

Heathkit® Manual

for the

AIRCRAFT NAVIGATION COMPUTER

Model OC-1401

595-2040

HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

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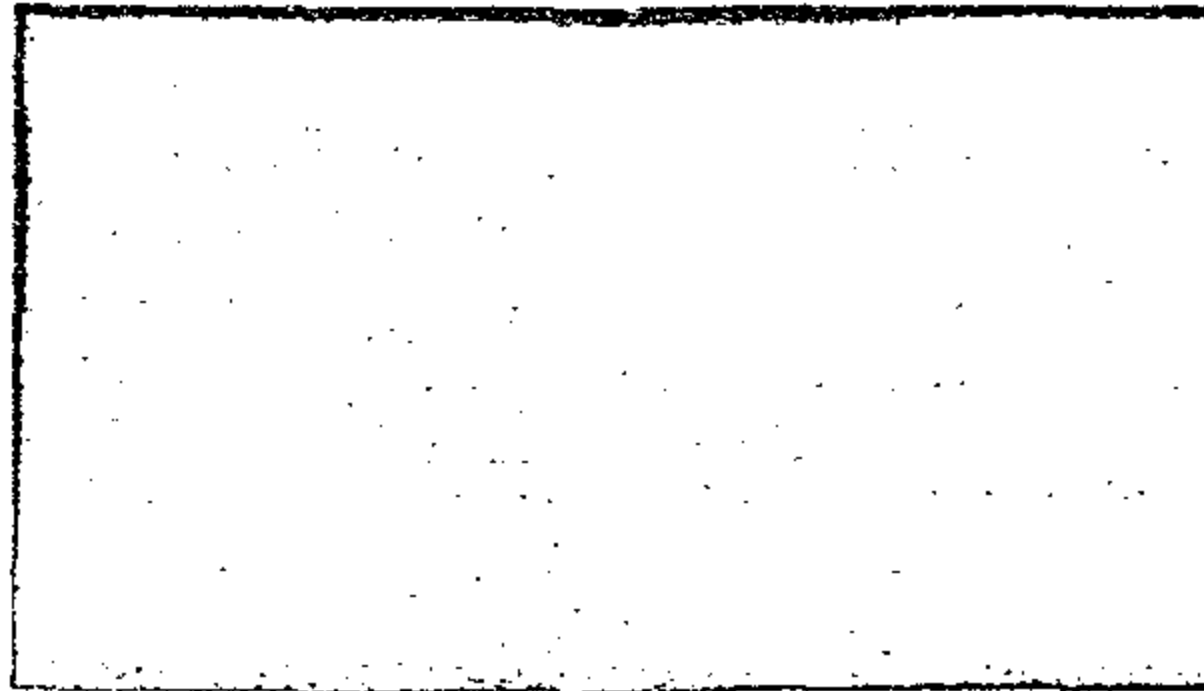
HEATH COMPANY PHONE DIRECTORY

The following telephone numbers are direct lines to the departments listed:

Kit orders and delivery information (616) 982-3411
Credit (616) 982-3561
Replacement Parts (616) 982-3571

Technical Assistance Phone Numbers

8:00 A.M. to 12 P.M. and 1:00 P.M. to 4:30 P.M., EST, Weekdays Only
R/C, Audio, and Electronic Organs (616) 982-3310
Amateur Radio (616) 982-3296
Test Equipment, Weather Instruments and
Home Clocks (616) 982-3315
Television (616) 982-3307
Aircraft, Marine, Security, Scanners, Automotive,
Appliances and General Products (616) 982-3496
Computers (616) 982-3309



YOUR HEATHKIT 90 DAY LIMITED WARRANTY

If you are not satisfied with our service - warranty or otherwise - or with our products, write directly to our Director of Customer Services, Heath Company, Benton Harbor, Michigan 49022. He will make certain your problems receive immediate, personal attention.

Our attorney, who happens to be quite a kitbuilder himself, insists that we describe our warranty using all the necessary legal phrases in order to comply with the new warranty regulations. Fine. Here they are:

For a period of ninety (90) days after purchase, Heath Company will replace or repair free of charge any parts that are defective either in materials or workmanship. You can obtain parts directly from Heath Company by writing us at the address below or by telephoning us at (616) 982-3571. And we'll pay shipping charges to get those parts to you — anywhere in the world.

We warrant that during the first ninety (90) days after purchase, our products, when correctly assembled, calibrated, adjusted and used in accordance with our printed instructions, will meet published specifications.

If a defective part or error in design has caused your Heathkit product to malfunction during the warranty period through no fault of yours, we will service it free upon proof of purchase and delivery at your expense to the Heath factory, any Heathkit Electronic Center (units of Schlumberger Products Corporation), or any of our authorized overseas distributors.

You will receive free consultation on any problem you might encounter in the assembly or use of your Heathkit product. Just drop us a line or give us a call. Sorry, we cannot accept collect calls.

Our warranty does not cover and we are not responsible for damage caused by the use of corrosive solder, defective tools, incorrect assembly, misuse, fire, or by unauthorized modifications to or uses of our products for purposes other than as advertised. Our warranty does not include reimbursement for customer assembly or set-up time.

This warranty covers only Heathkit products and is not extended to allied equipment or components used in conjunction with our products. We are not responsible for incidental or consequential damages. Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

HEATH COMPANY
BENTON HARBOR, MI. 49022

Prices and specifications subject to change without notice.

TABLE OF CONTENTS

INTRODUCTION	3	Display Control	6
ASSEMBLY NOTES	4	Display Control Keys	6
PARTS LIST	7	Fixed Point Display	6
STEP-BY-STEP ASSEMBLY		Scientific Notation Display	6
Batteries	9	Automatic Display Switching	6
Circuit Board	10	Keying in Exponents of Ten	6
OPERATION		Computer Overflow	6
Familiarization	28	Automatic Memory Stack	
Display	28	Manipulating Stack Contents	6
Clearing	28	Clearing the Display	7
Keyboard	28	The "Enter" Key	7
Clearing Prefix	29	One-Number Functions and the Stack	7
Keying in Numbers	29	Two-Number Functions and the Stack	7
Negative Numbers	29	Chain Arithmetic	7
Vector Format	30	Order of Execution	7
Time Format	30	Weight and Balance	
Error Display	31	Calculation	8
Low Battery Display	31	Last X-register	8
Flight Functions		Correcting Input Errors	8
Introduction	32	Function Keys	
Flight Key Functions	32	Reciprocals	8
Preflight Keys	32	Reciprocal Angle	8
In-flight Keys	32	Finding Square Roots	8
Navigation Keys	33	Squaring Numbers	8
Time Function Keys	34	Using π	8
Typical Flight Plan	34	Trigonometric Functions	8
Loading Preflight Data	35	Decimal Hours/Hours, Minutes,	
Recalling Preflight Data	37	Seconds Conversions	8
Flight Plan Data	37	Adding and Subtracting Time	8
Standby Mode	39	Vector Arithmetic	8
Clock Functions	40	Logarithmic and Exponential	
In-flight Computations	41	Functions	8
Navigation		Raising Numbers to Powers	8
Distance and Angle from VOR 1		Storing and Recalling Numbers	9
to VOR 2	48	Storage Registers	9
Distance and Angle from VOR 1		Clearing Storage Registers	9
to Checkpoint	48	IMPROPER OPERATIONS	9
Radials for VOR 1 and VOR 2	49	IN CASE OF DIFFICULTY	
Distance and Magnetic Heading	50	General Troubleshooting Information	9
Distance and Angle from VOR 1		Troubleshooting Chart	9
to Plane	50	SPECIFICATIONS	9
In-flight Variations	52	CIRCUIT DESCRIPTION	9
Other Useful Functions	55	CIRCUIT BOARD X-RAY VIEW	9
A Final Reminder	56	SEMICONDUCTOR IDENTIFICATION	
Advanced Mathematics		CHART	10
Two-Number Functions	57	SCHEMATIC	(Illustration Booklet, Page 4)
Chain Calculations	58	WARRANTY	Inside front cover
		CUSTOMER SERVICE	Inside rear cover



INTRODUCTION

The Heathkit Model OC-1401 Aircraft Navigation Computer is a compact, handheld, electronic digital Computer. It is designed for aircraft pilots, and provides basic math, special navigation and flight management, and scientific functions. Many of the features in your Computer make it the most sophisticated and useful instrument of its type. This is made possible by three custom-designed, microprocessor integrated circuits.

Computer entries are made on a 36-key keyboard and the entries and answers are clearly displayed on a 14-digit, 7-segment display. Also, a "Standby" mode allows you to turn the display off after you make entries to conserve battery power.

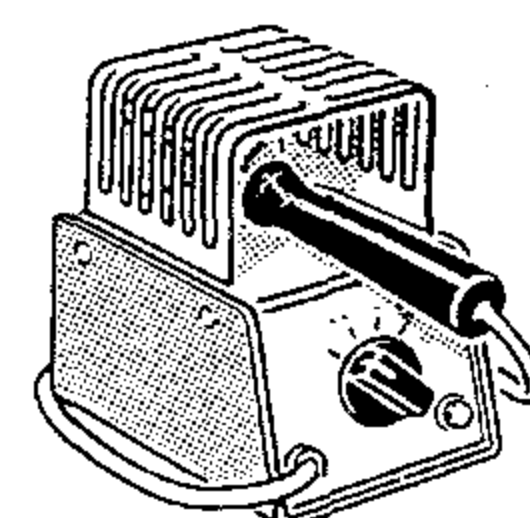
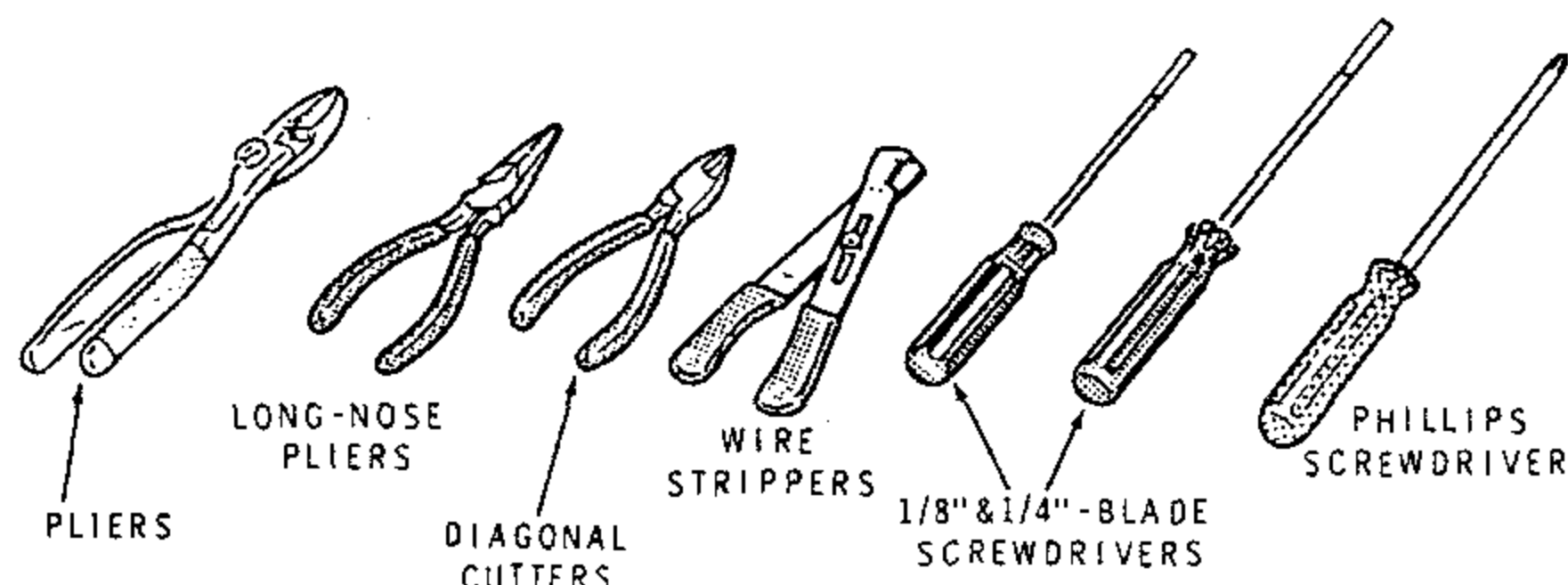
The Computer contains its own rechargeable, nickel-cadmium batteries that provide many hours of reliable operation. However, when the batteries do get low, the "low-battery indicator" automatically turns on. Separate chargers are supplied to recharge the batteries (as well as power the Computer) at locations where 120 VAC, 60 Hz or 12 VDC (with cigarette lighter type connector) is available.

All of these features and innovations are incorporated into your Navigation Computer to give you many years of trouble-free operation.

ASSEMBLY NOTES

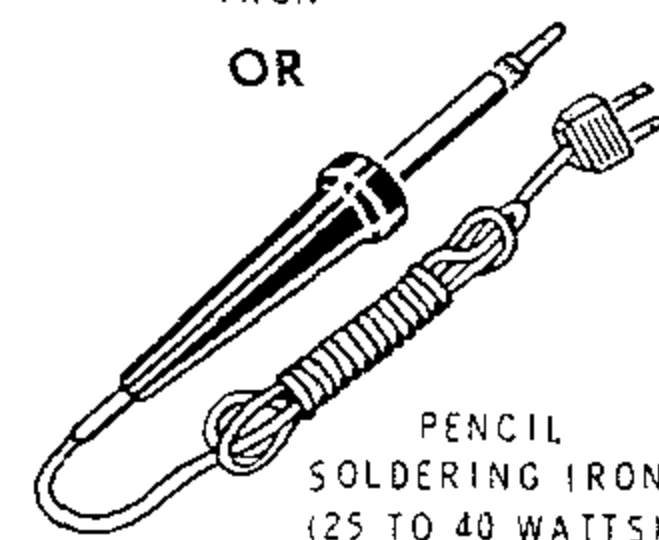
TOOLS

You will need these tools to assemble your kit.



HEATHKIT
SOLDERING
IRON

OR

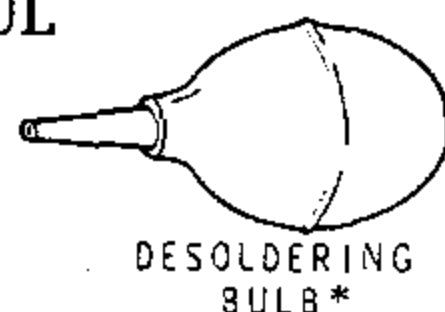


PENCIL
SOLDERING IRON
(25 TO 40 WATTS)

OTHER HELPFUL TOOLS



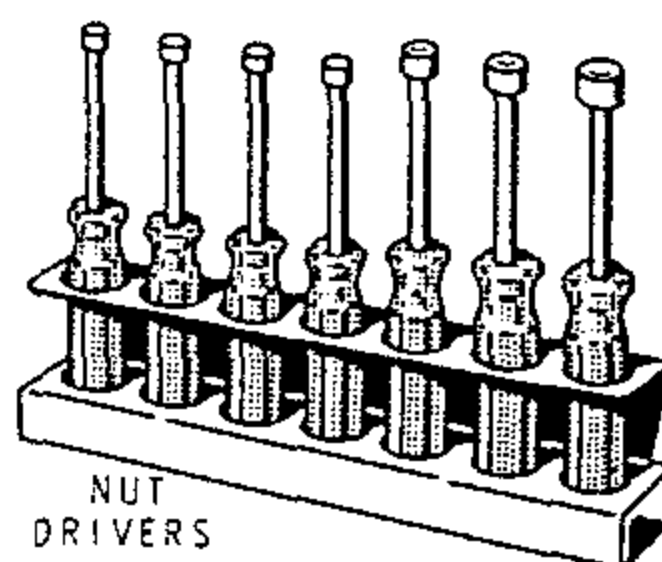
NUT STARTER
(MAY BE SUPPLIED
WITH KIT)



DESOLDERING
BULB*



DESOLDERING
BRAID*



NUT
DRIVERS

*TO REMOVE SOLDER FROM CIRCUIT CONNECTIONS.

ASSEMBLY

1. Follow the instructions carefully. Read the entire step before you perform each operation.
2. The illustrations in the Manual are called Pictorials and Details. Pictorials show the overall operation for a group of assembly steps; Details generally illustrate a single step. When you are directed to refer to a certain Pictorial "for the following steps," continue using that Pictorial until you are referred to another Pictorial for another group of steps.
3. Most kits use a separate "Illustration Booklet" that contains illustrations (Pictorials, Details, etc.) that are too large for the Assembly Manual. Keep the "Illustration Booklet" with the Assembly Manual. The illustrations in it are arranged in Pictorial number sequence.
4. Position all parts as shown in the Pictorials.
5. Solder a part or a group of parts only when you are instructed to do so.



6. Each circuit part in an electronic kit has its own component number (R2, C4, etc.). Use these numbers when you want to identify the same part in the various sections of the Manual. These numbers, which are especially useful if a part has to be replaced, appear:
- In the Parts List,
 - At the beginning of each step where a component is installed,
 - In some illustrations,
 - In the Schematic,
 - In the section at the rear of the Manual.
7. When you are instructed to cut something to a particular length, use the scales (rulers) provided at the bottom of the Manual pages.

SAFETY WARNING: Avoid eye injury when you cut off excess lead lengths. Hold the leads so they cannot fly toward your eyes.

SOLDERING

Soldering is one of the most important operations you will perform while assembling your kit. A good solder connection will form an electrical connection between two parts, such as a component lead and a circuit board foil. A bad solder connection could prevent an otherwise well-assembled kit from operating properly.

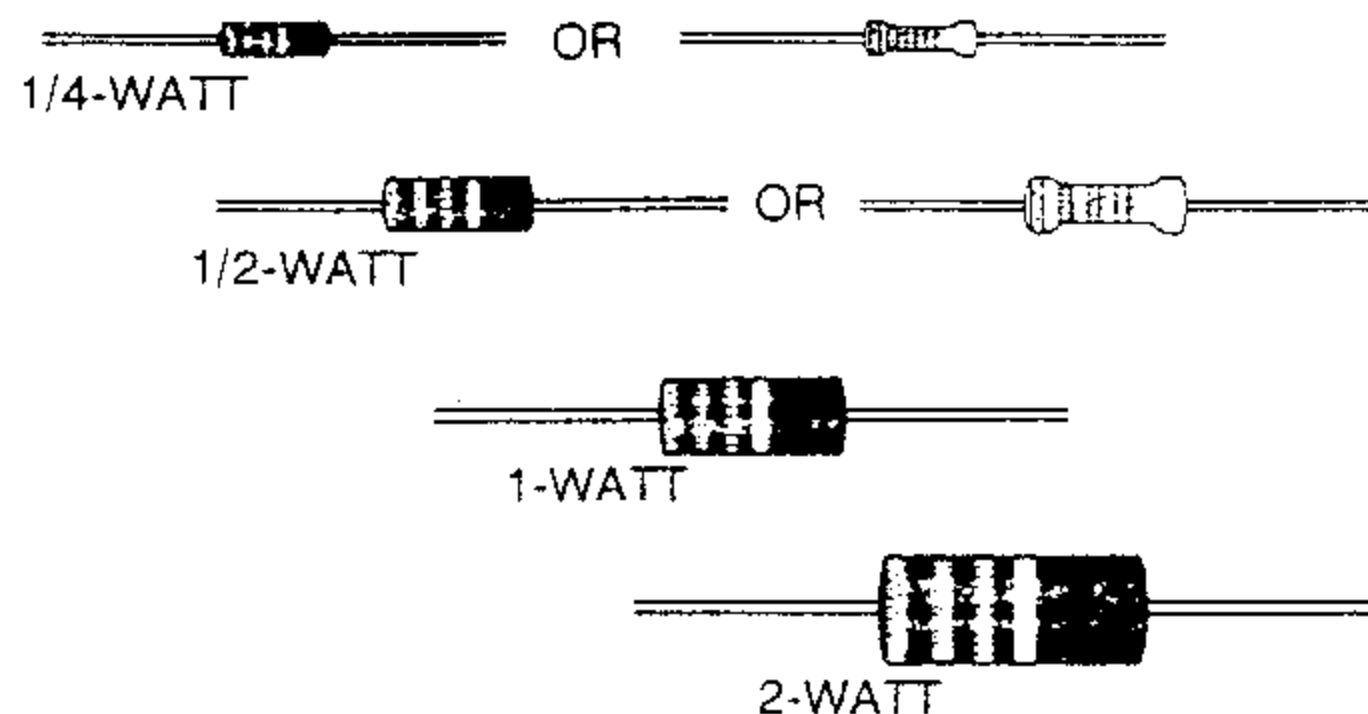
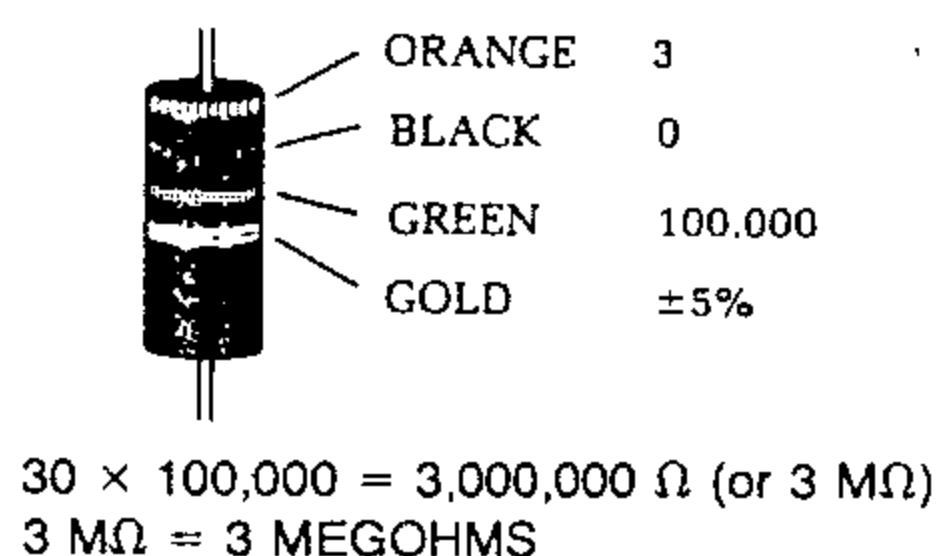
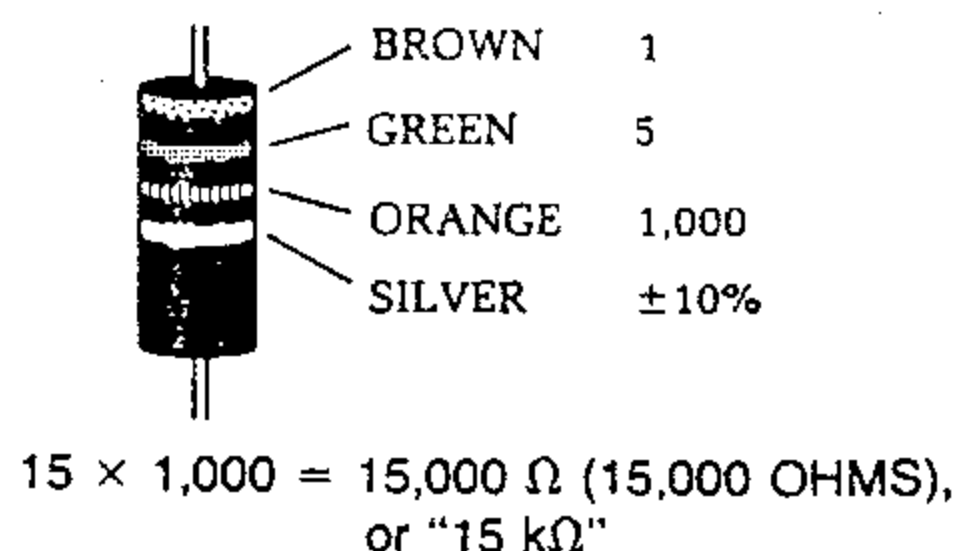
It is easy to make a good solder connection if you follow a few simple rules:

1. Use the right type of soldering iron. A 25 to 40-watt pencil soldering iron with a 1/8" or 3/16" chisel or pyramid tip works best.
2. Keep the soldering iron tip clean. Wipe it often on a wet sponge or cloth; then apply solder to the tip to give the entire tip a wet look. This process is called tinning, and it will protect the tip and enable you to make good connections. When solder tends to "ball" or does not stick to the tip, the tip needs to be cleaned and retinned.

PARTS

Resistors will be called out by their resistance value in Ω (ohms), $k\Omega$ (kilohms), or $M\Omega$ (megohms). Certain types of resistors will have the value printed on the body, while others will be identified by a color code. The colors of the bands and the value will be given in the steps, therefore the following color code is given for information only.

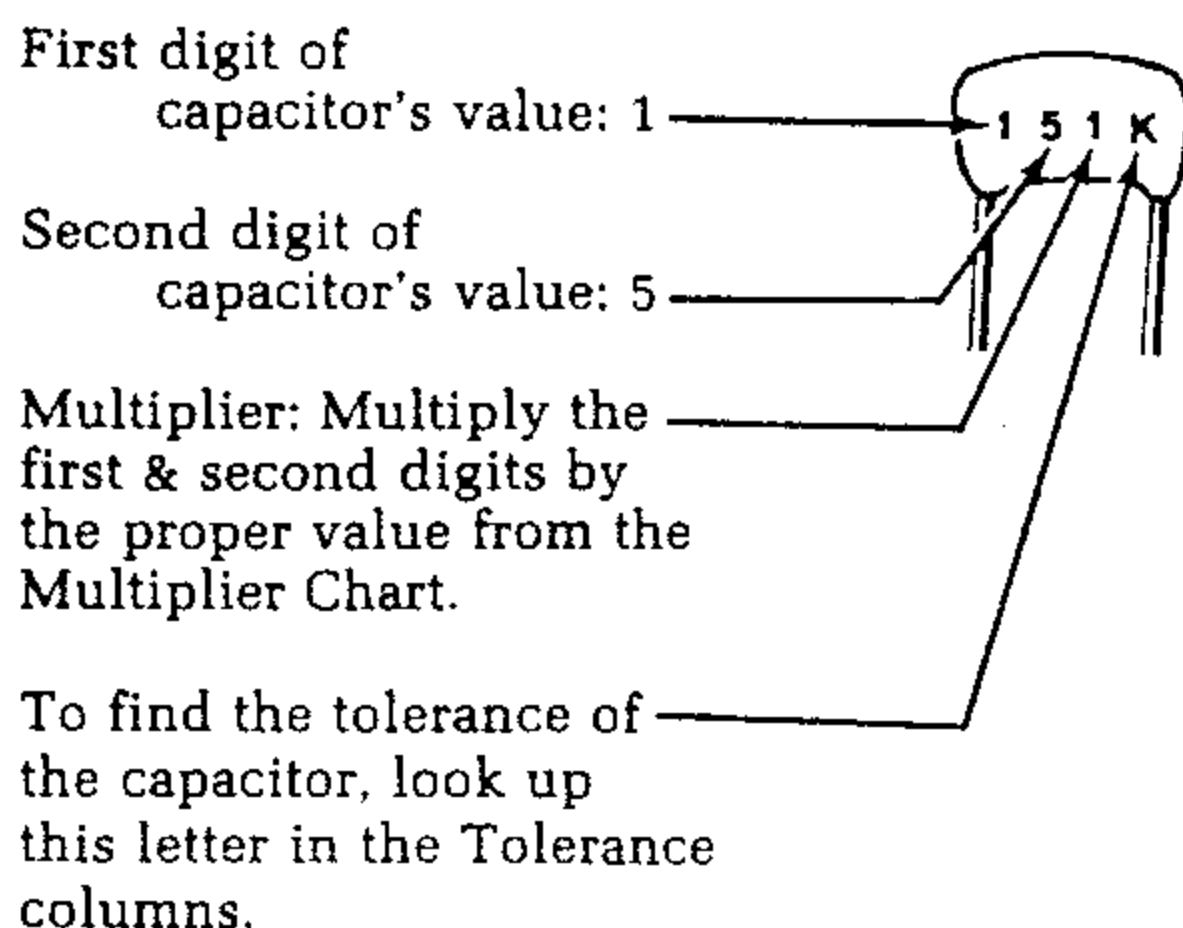
EXAMPLES:



RESISTOR COLOR CODE

COLOR	1st DIGIT	2nd DIGIT	MULTIPLY BY
BLACK	0	0	1
BROWN	1	1	10
RED	2	2	100
ORANGE	3	3	1,000
YELLOW	4	4	10,000
GREEN	5	5	100,000
BLUE	6	6	1,000,000
VIOLET	7	7	10,000,000
GRAY	8	8	100,000,000
WHITE	9	9	1,000,000,000
GOLD			.1
SILVER			.01

Capacitors will be called out by their capacitance value in μF (microfarads) or pF (picofarads) and type: ceramic, Mylar*, electrolytic, etc. Some capacitors may have their value printed in the following manner:



EXAMPLES:

$$151K = 15 \times 10 = 150 \text{ pF}$$

$$759 = 75 \times 0.1 = 7.5 \text{ pF}$$

NOTE: The letter "R" may be used at times to signify a decimal point; as in: 2R2 = 2.2 (pF or μF).

MULTIPLIER		TOLERANCE OF CAPACITOR		
FOR THE NUMBER:	MULTIPLY BY:	10pF OR LESS	LETTER	OVER 10pF
0	1	$\pm 0.1 \text{ pF}$	B	
1	10	$\pm 0.25 \text{ pF}$	C	
2	100	$\pm 0.5 \text{ pF}$	D	
3	1000	$\pm 1.0 \text{ pF}$	F	$\pm 1\%$
4	10,000	$\pm 2.0 \text{ pF}$	G	$\pm 2\%$
5	100,000		H	$\pm 3\%$
			J	$\pm 5\%$
8	0.01		K	$\pm 10\%$
9	0.1		M	$\pm 20\%$

*DuPont Registered Trademark

PARTS LIST

Check each part against the following list. Any part that is packed in an individual envelope with the part number on it should be placed back in the envelope after you identify it until it is called for in a step. Do not discard any packing materials until all parts are accounted for. The key numbers correspond to the numbers on the Parts Pictorial (Illustration Booklet, Page 1).

CAUTION: Most of the integrated circuits can be damaged by static voltage. Since these parts represent a considerable portion of the cost of the kit, do not remove them from their packages until you are instructed to do so.

To order a replacement part, always include the **PART NUMBER**. Use the Parts Order Form furnished with this kit. If one is not available, see "Replacement Parts" inside the rear cover of the Manual. Your Warranty is located inside the front cover. For prices, refer to the separate "Heath Parts Price List."

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
------------	-------------------	------	-------------	----------------------

RESISTORS

1/4-Watt (fourth band gold)

A1	6-331-12	2	330 Ω (orange-orange-brown)	R7, R9
A1	6-472-12	3	4700 Ω (yellow-violet-red)	R3, R6, R8
A1	6-105-12	2	1 M Ω (brown-black-green)	R1, R2

1/8-Watt, 1%

A2	2-5-11	1	1755 Ω (1.755k)	R4
A2	2-18-11	1	10 k Ω	R5

CAPACITORS

B1	27-63	1	.022 μ F Mylar	C1
B2	25-276	1	4.7 μ F (4.7M) tantalum	C3
B2	25-253	1	33 μ F (33M) tantalum	C2

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
------------	-------------------	------	-------------	----------------------

DIODES — TRANSISTORS — INTEGRATED CIRCUITS

C1	56-602	3	Germanium diode	D1, D2, D3
----	--------	---	-----------------	------------

NOTE: Transistors and integrated circuits are marked for identification in one of the following four ways:

1. Part number.
2. Type number. (For integrated circuits, this refers only to the numbers; the letters may vary.)
3. Part number and type number.
4. Part number with a type number other than the one listed.

C2	417-235	3	2N4121 transistor	Q1, Q2, Q3
C2	417-801	1	MPSA20 transistor	Q4
C3	443-846	1	DS8867 18-pin integrated circuit	IC6
C4	443-847	1	DS8664 24-pin integrated circuit	IC5

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
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Diodes — Transistors — Integrated Circuits (cont'd.)

CAUTION: The following integrated circuits can be damaged by static electricity. Do not remove them from their packaging until you are instructed to do so in a step.

C5	443-845	1	3539 22-pin integrated circuit	IC1
C6	444-14	1	40-pin integrated circuit	IC4
C6	444-15	1	40-pin integrated circuit	IC3
C6	444-16	1	40-pin integrated circuit	IC2

SWITCH — CRYSTAL — DISPLAY

D1	60-623	2	Slide switch	SW1, SW2
D2	404-238	1	Crystal	Y1
D3	411-828	1	LED display assembly	

KEYBOARD — CHARGERS — BATTERY

E1	100-1714	1	Keyboard
E2	150-69	1	AC-charger
E3	150-70	1	DC charger
E4	418-32	4	Battery

CONNECTOR — SOCKETS

F1	432-1011	3	Connector pin
F2	434-306	4	12-pin socket strip
F3	434-297	6	20-pin IC socket strip
F4	434-296	1	18-pin IC socket

WINDOW — CABINET PARTS

G1	446-689	1	Window
	305-50	1	Cabinet parts consist of:
G2	96-676	1	Cabinet top
G3	92-677	1	Cabinet bottom
G4	94-590	1	Sun shield

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
---------	----------------	------	-------------	-------------------

SCREWS

H1	250-186	4	#4 × 3/8" self-tapping screw
H2	250-1266	2	#4 × 9/16" black screw
H3	250-114	2	4-40 × 1-1/4" black screw

WIRE — SLEEVING — CABLE

340-8	24"	Bare wire
344-90	6"	Black wire
344-92	6"	Red wire
346-1	1"	Sleeving
347-55	12"	8-wire cable

MISCELLANEOUS

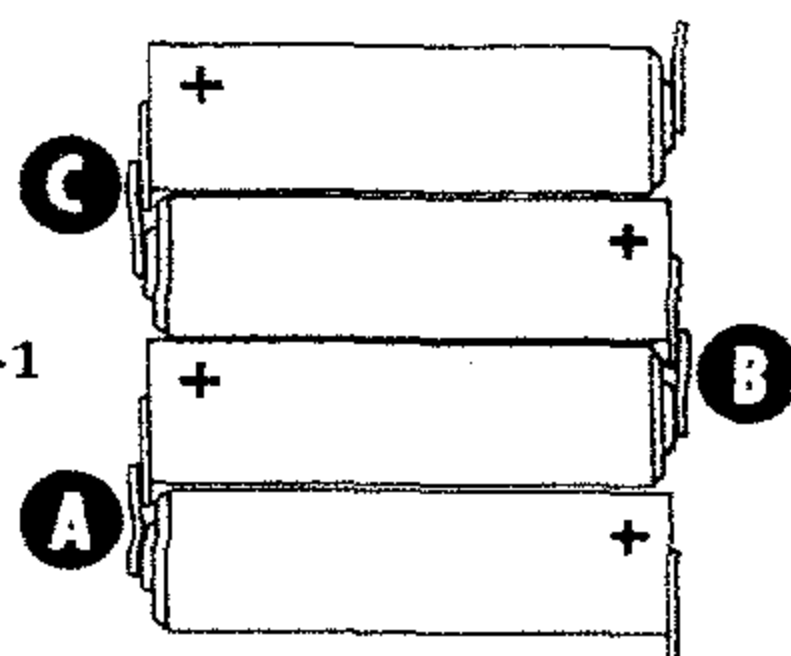
J1	73-39	2"	Foam tape
J2	75-750	2	Velcro* tape
	85-2150-2	1	Main circuit board
J3	258-712	1	Spring
J4	261-50	4	Rubber foot
J5	382-75	1	Foam pad
	305-63		Label package consists of:
J6	390-1451	1	Keyboard label with math functions.
	390-1452	1	Keyboard label without math functions.
J7	390-1453	1	Label set
J8	406-664	1	Magnifier
	391-34	1	Blue and white label
	597-260	1	Parts Order Form
		1	Assembly Manual (See Page 1 for part number.)
		1	Operation Guide (See Page 1 for part number.)

Solder—

*Velcro Corp. Registered Trademark

STEP-BY-STEP ASSEMBLY

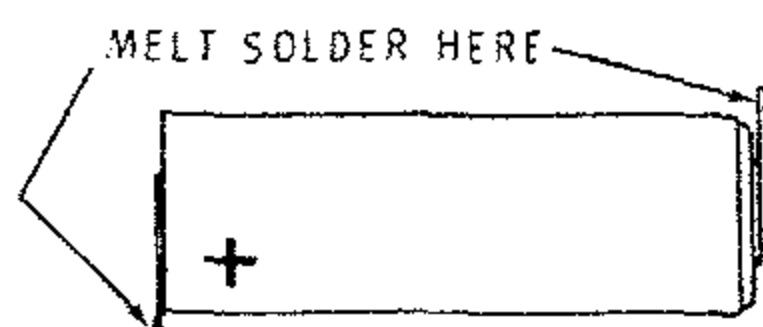
PICTORIAL 1-1



BATTERIES

Refer to Pictorial 1-1 for the following steps.

- () Refer to Detail 1-1A and make sure both tabs of a battery are straight as shown. Then melt a small amount of solder onto both tabs as shown in Detail 1-1B.
- () In a similar manner, melt solder onto the tabs of the remaining three batteries.
- () Position the four batteries so their plus (+) ends are as shown in the Pictorial. Be sure the batteries are as close together as possible. Then solder the tabs together at A, B, and C.
- () Set the batteries aside until they are called for in a step.

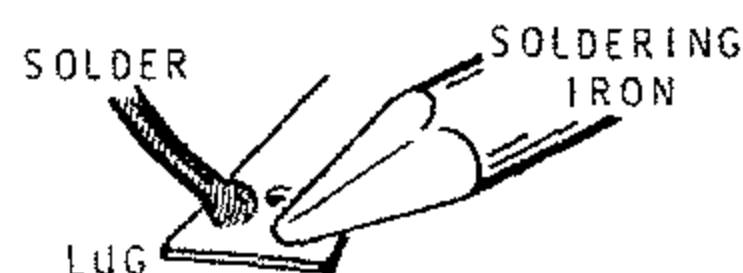


Detail 1-1A

1. Push the soldering iron tip against the lug. Heat the lug for two or three seconds.



2. Apply solder to the lug, not to the soldering iron. IMPORTANT: Let the heat of the lug melt the solder.



3. As the solder begins to melt, allow it to flow over the lug. Then remove the solder and the iron and let the lug cool.



Detail 1-1B

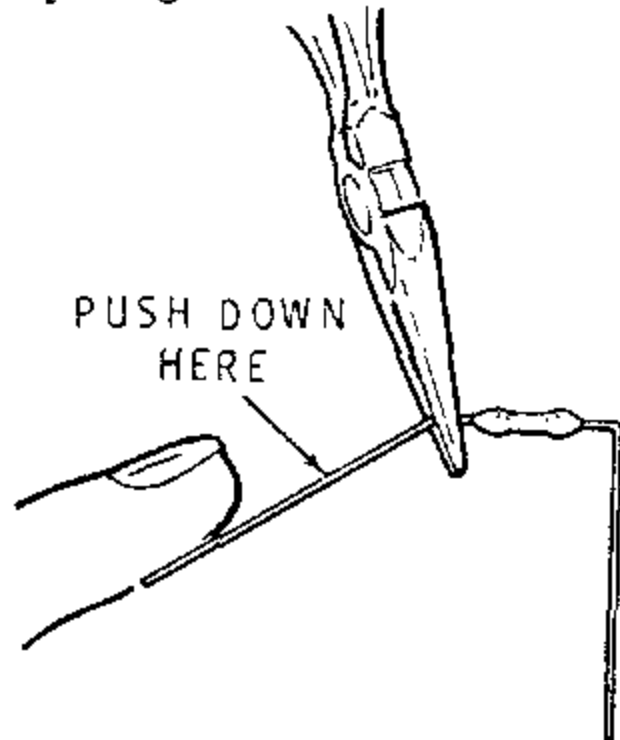
CIRCUIT BOARD

START ➡

In the following steps, you will be given detailed instructions on how to install and solder the first part on the circuit board. Read and perform each step carefully. Then use the same procedure whenever you install parts on the circuit board.

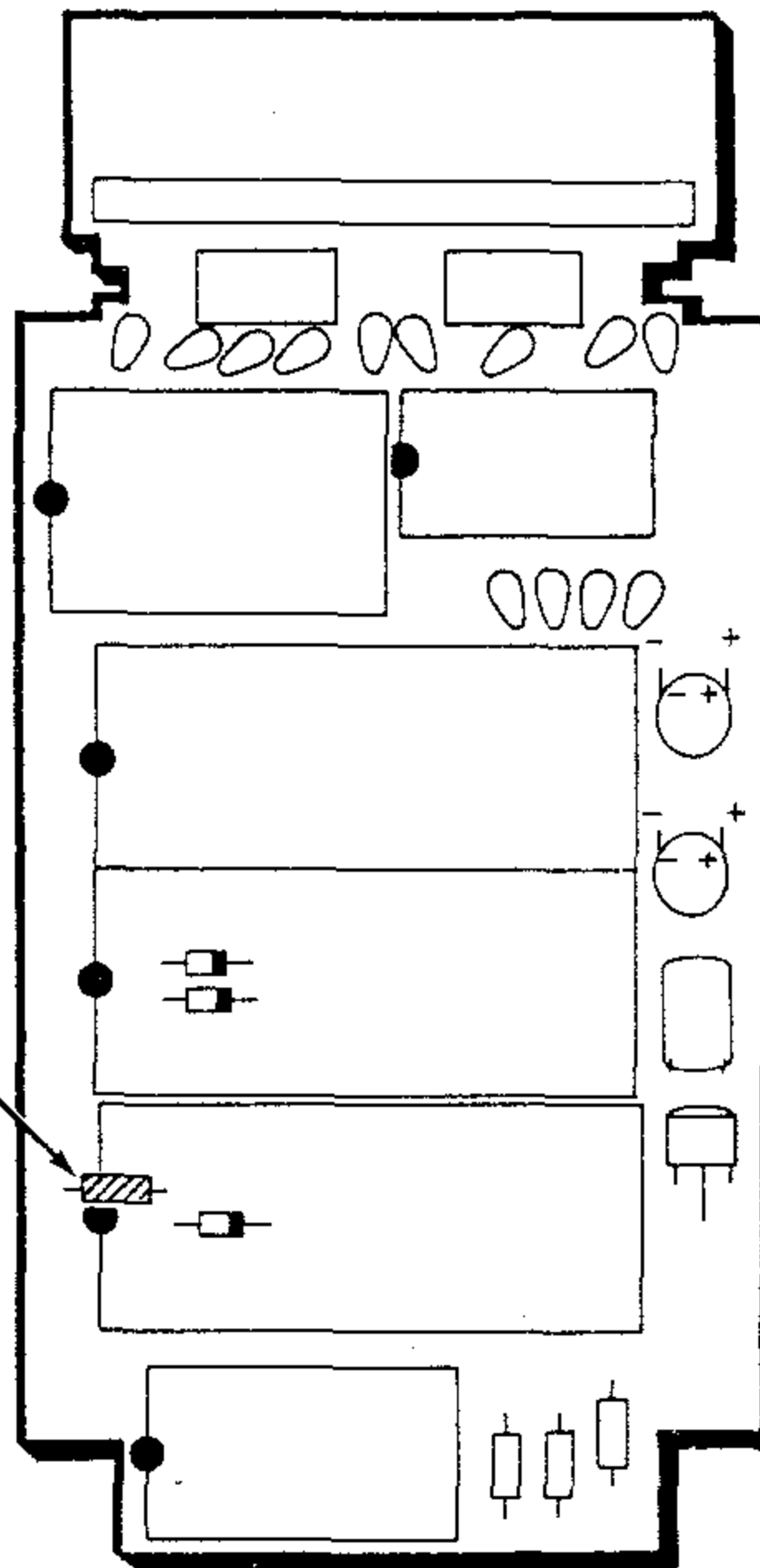
- () Position the main circuit board as shown.

- () R8: Hold a 4700 Ω (yellow-violet-red) resistor as shown and bend the leads straight down with long-nose pliers to fit the hole spacing on the circuit board.



- () Push the leads through the holes at the indicated location on the circuit board. The end with color bands may be positioned either way.

- () Press the resistor against the circuit board. Then bend the leads outward slightly to hold the resistor in place.

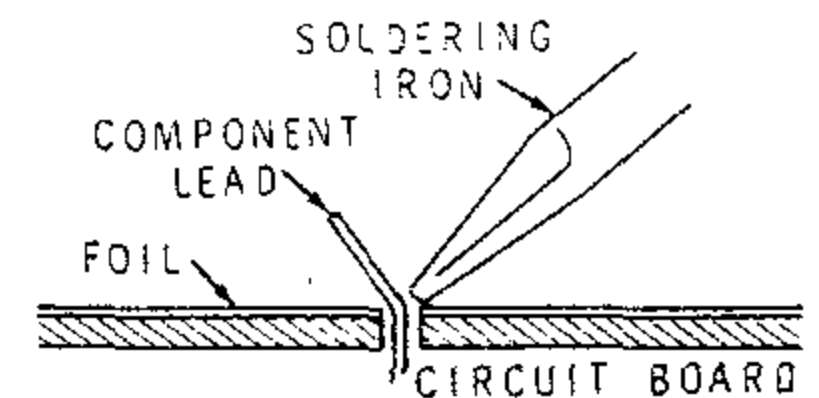


PICTORIAL 2-1

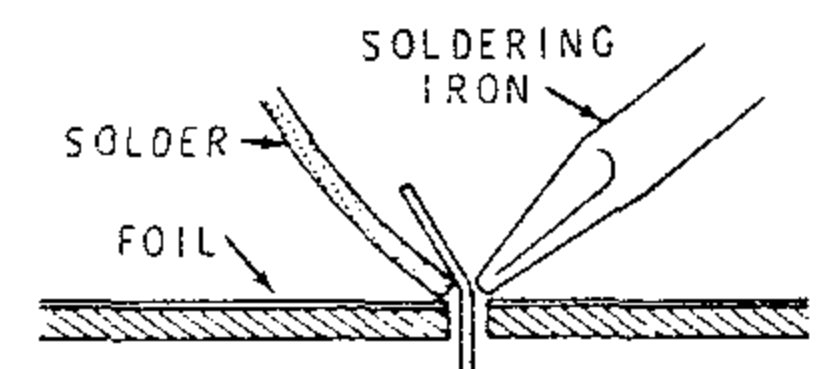
CONTINUE ➡

- () Solder the resistor leads to the circuit board as follows:

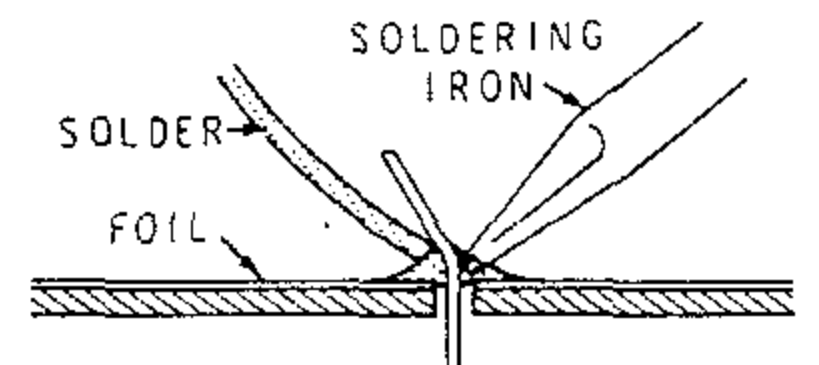
1. Turn the circuit board over and push the soldering iron tip against both the lead and the circuit board foil. Heat both for two or three seconds.



2. Then apply solder to the other side of the connection. **IMPORTANT:** Let the heated lead and the circuit board foil melt the solder.



3. As the solder begins to melt, allow it to flow around the connection. Then remove the solder and the iron and let the connection cool.

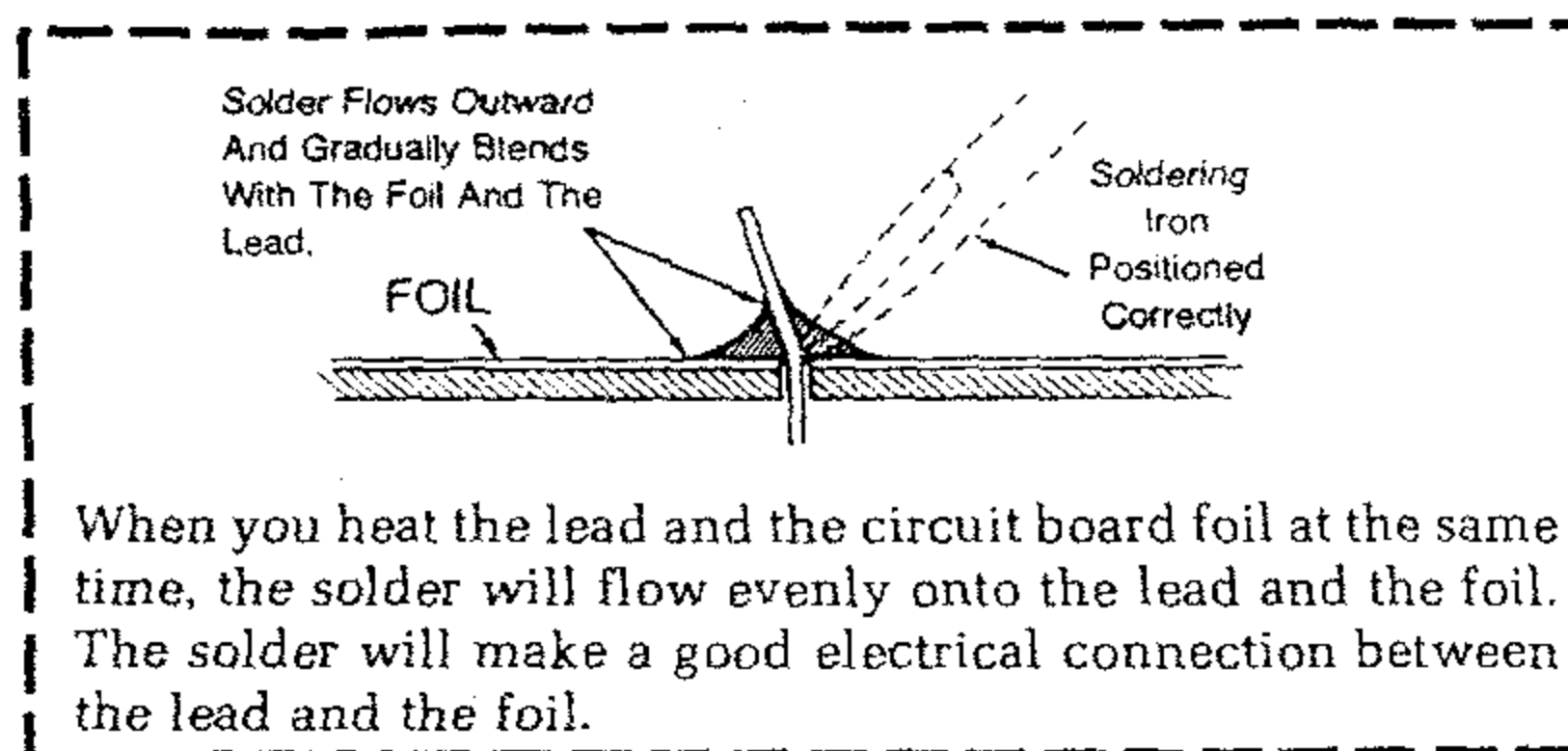


- () Cut off the excess lead lengths close to the connection. **WARNING:** Clip the leads so the ends will not fly toward your eyes.

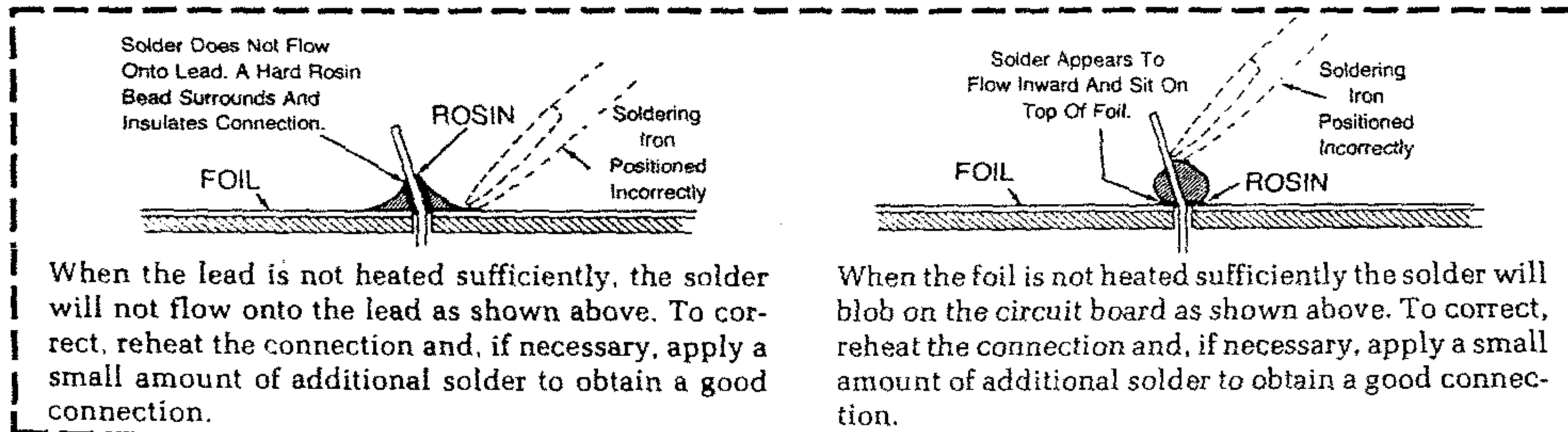
- () Check each connection. Use the magnifier (supplied with your kit) and compare each connection to the illustrations on Page 11. After you have checked the solder connections, proceed with the assembly on Page 12. Use the same soldering procedure for each connection.



A GOOD SOLDER CONNECTION



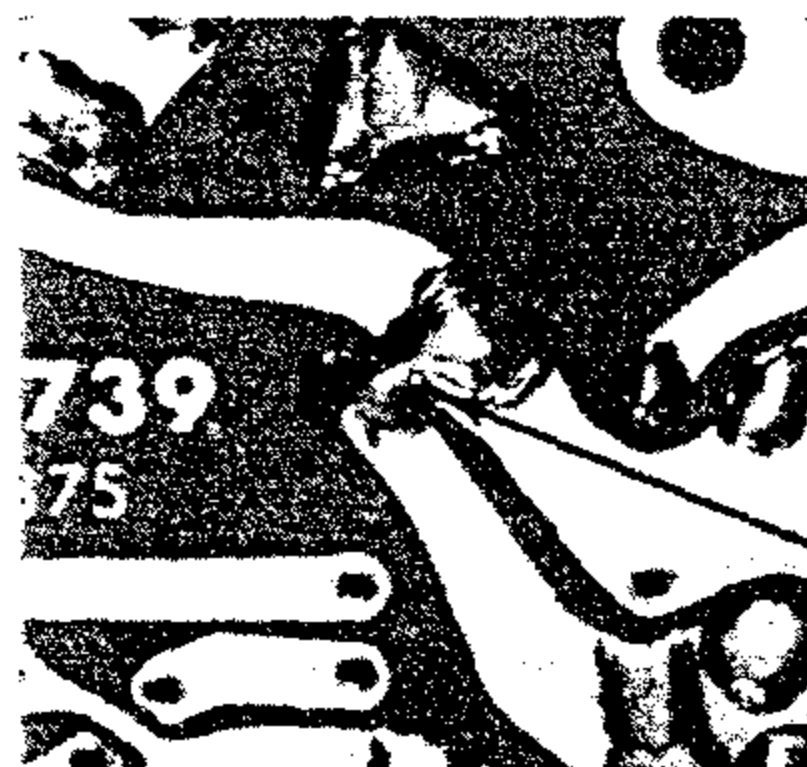
POOR SOLDER CONNECTIONS



SOLDER BRIDGES

A solder bridge between two adjacent foils is shown in photograph A. Photograph B shows how the connection should appear. A solder bridge may occur if you accidentally touch an adjacent previously soldered connection, if you use too much solder, or if you "drag" the soldering iron across other foils as you remove it from the connection. A good rule to follow is: always take a good look at the foil area around each lead before you solder it. Then, when you solder the connection, make sure the solder remains in this area and does not bridge to another foil. This is especially important when the foils are small and close together. NOTE: It is alright for solder to bridge two connections on the same foil.

Use only enough solder to make a good connection, and lift the soldering iron straight up from the circuit board. If a solder bridge should develop, turn the circuit board foil-side-down and heat the solder between connections. The excess solder will run onto the tip of the soldering iron, and this will remove the solder bridge. NOTE: The foil side of most circuit boards has a coating on it called "solder resist." This is a protective insulation to help prevent solder bridges.



A

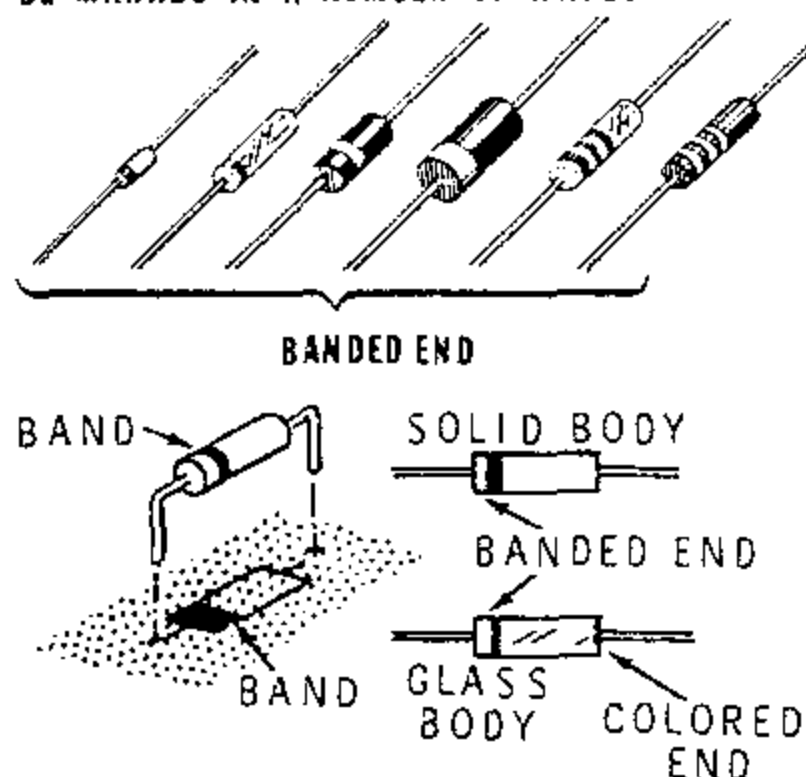
SOLDER BRIDGE



B

START

IMPORTANT: THE BANDED END OF DIODES CAN BE MARKED IN A NUMBER OF WAYS.



If your diode has a solid body, the band is clearly defined. If your diode has a glass body, do not mistake the colored end inside the diode for the banded end. Look for a band painted on the outside of the glass.

NOTE: When you install diodes, as in the following steps, be sure you position the banded end of each diode as it is shown on the circuit board.

Install three germanium diodes (#56-602).

- () D3
- () D2
- () D1

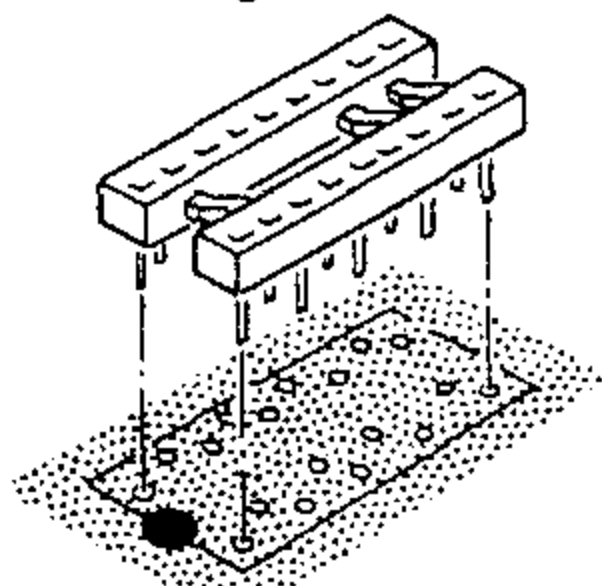
() R2: 1 M Ω (brown-black-green).

() R3: 4700 Ω (yellow-violet-red).

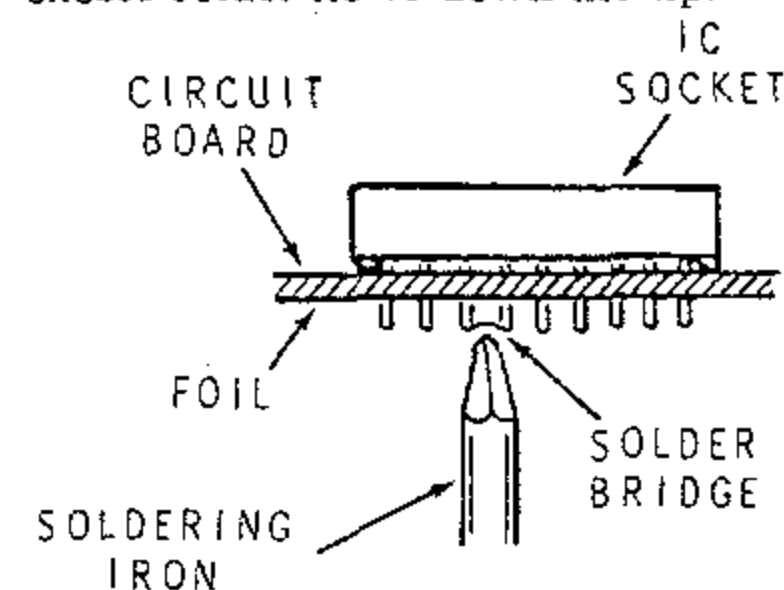
() R1: 1 M Ω (brown-black-green).

- () Turn the circuit board over and solder the leads to the foil. Then cut off the excess lead lengths.

You will install an IC socket in the next step. Be sure the socket pins are straight. Insert the pins in their respective holes, turn the circuit board over, and solder them to the foil. Be sure the socket is down on the circuit board and all the pins protrude through the board.

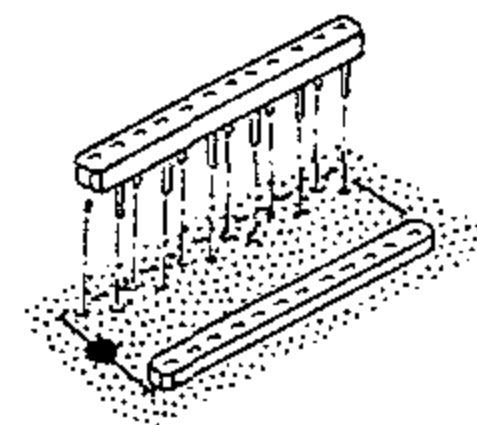
**CONTINUE**

If a solder bridge occurs, clean the soldering iron tip and place it between the two points that are bridged until the excess solder flows down the tip.

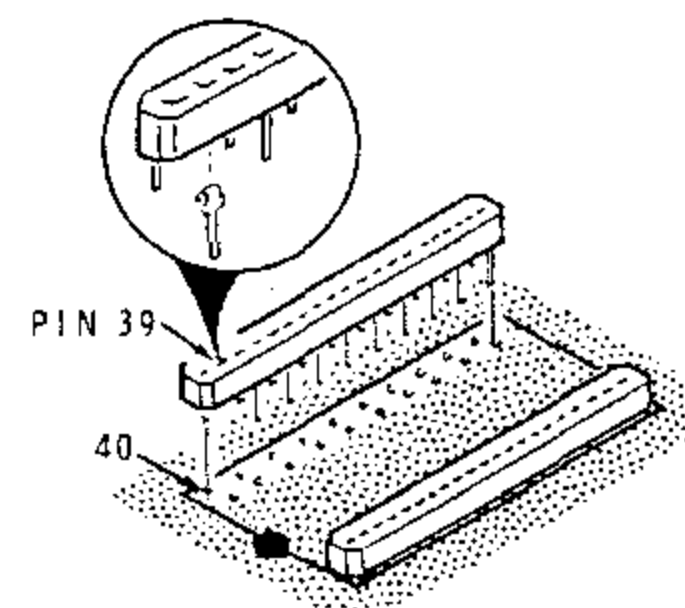


- () 18-pin IC socket at IC6.

- () Two 12-pin socket strips at IC5. Insert the pins and solder the two end pins to the foil. Then make sure the socket is not tilted and is flush against the circuit board before you solder the remaining pins.



- () Two 20-pin socket strips at IC4. First pull out the indicated pin (pin 39) from one of the strips.



- () Two 20-pin socket strips at IC3. Again remove pin 39 from a strip.

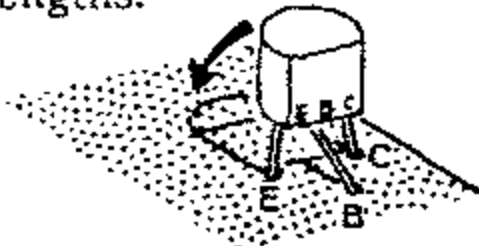
- () Two 20-pin socket strips at IC2. Do not remove a pin from either of these strips.

PICTORIAL 2-2

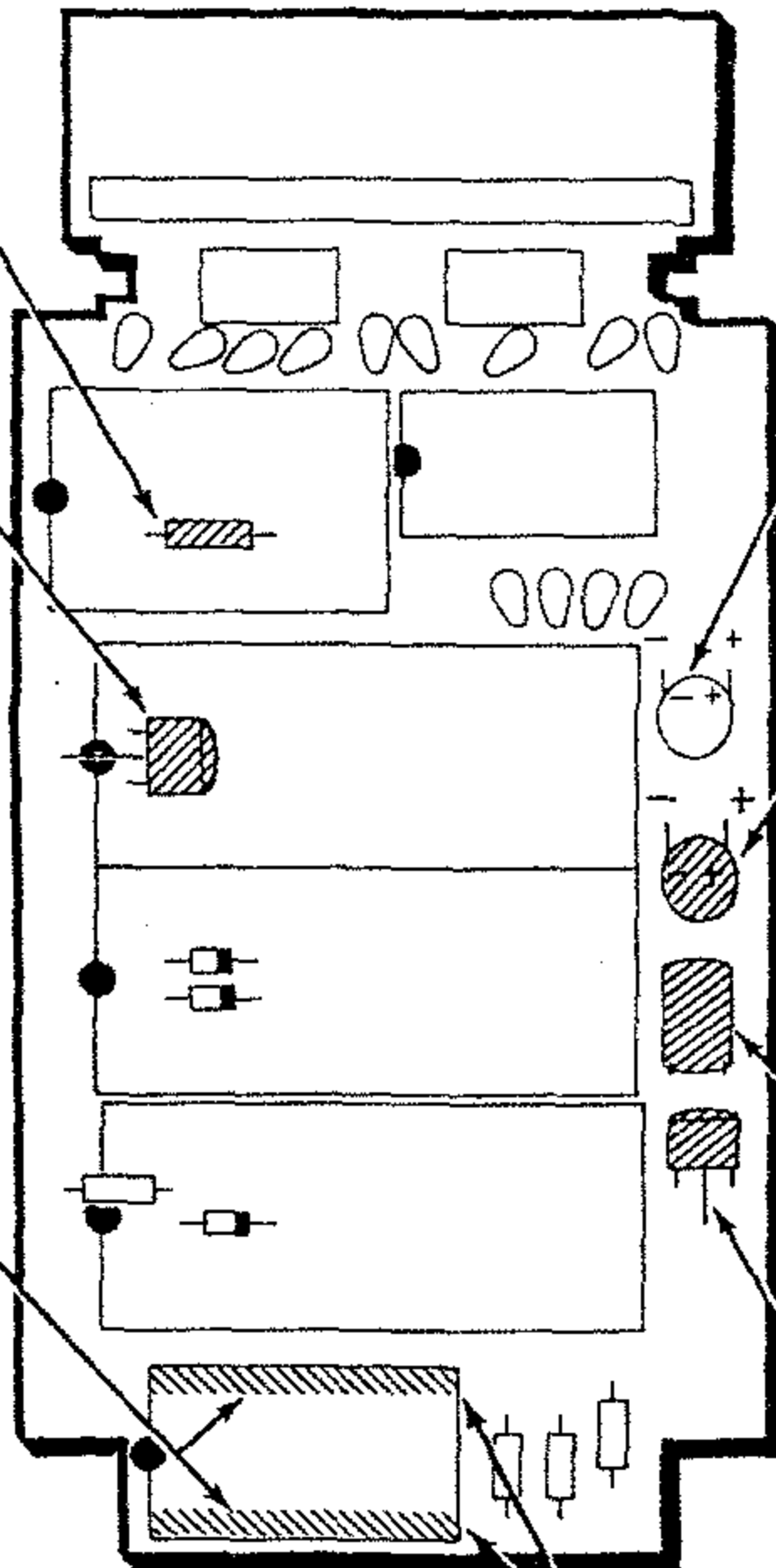
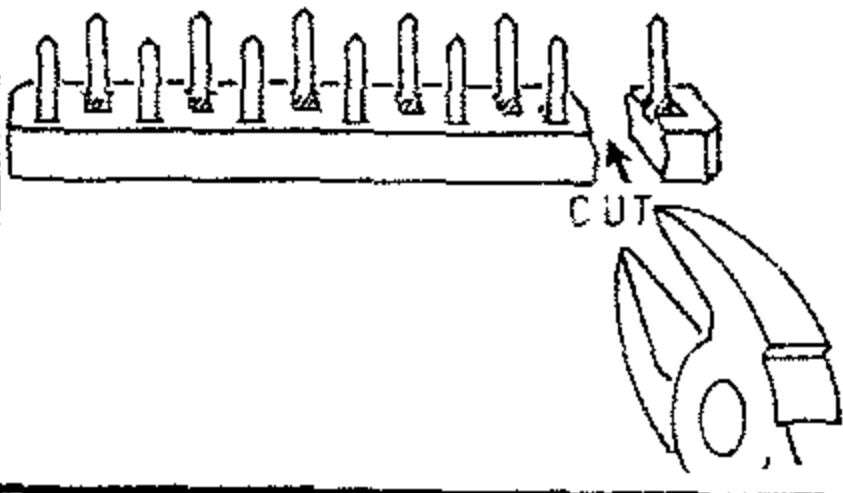
START

() R9: 330 Ω (orange-orange-brown). Solder the leads to the foil and cut off the excess lead lengths.

() Q4: MPSA20 transistor (#417-801). Install the E, B, and C leads as shown; bend the transistor down against the circuit board, and solder its leads to the foil. Then cut off the excess lead lengths.



() Two 12-pin socket strips at IC1. First, carefully cut one section off each strip as shown. Cut it from either end.



CUTOFF
END

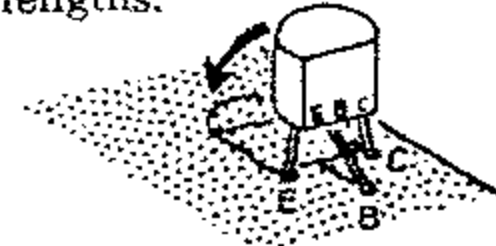
CONTINUE

() Do not install a capacitor here.

() C3: 4.7 μ F (4.7M) tantalum. (The circuit board is not marked.) Match the positive (+) or dot marked lead of the capacitor with the positive (+) mark on this Pictorial, insert the leads into the circuit board holes, bend the capacitor down against the circuit board, and solder the leads to the foil. Then cut off the excess lead lengths.

() C1: .022 μ F Mylar. Bend the capacitor down against the circuit board, solder its leads to the foil, and cut off the excess lead lengths.

() Q1: 2N4121 transistor (#417-235). Install the E, B, and C leads as shown; bend the transistor down against the circuit board, and solder its leads to the foil. Then cut off the excess lead lengths.



PICTORIAL 2-3

START →

() Turn the circuit board over and position it as shown.

() R4: 1755 Ω (1.755k), 1%.

() R3: 10 k Ω , 1%.

() R6: 4700 Ω (yellow-violet-red).

() R7: 330 Ω (orange-orange-brown).

() Solder the leads to the foil and cut off the excess lead lengths.

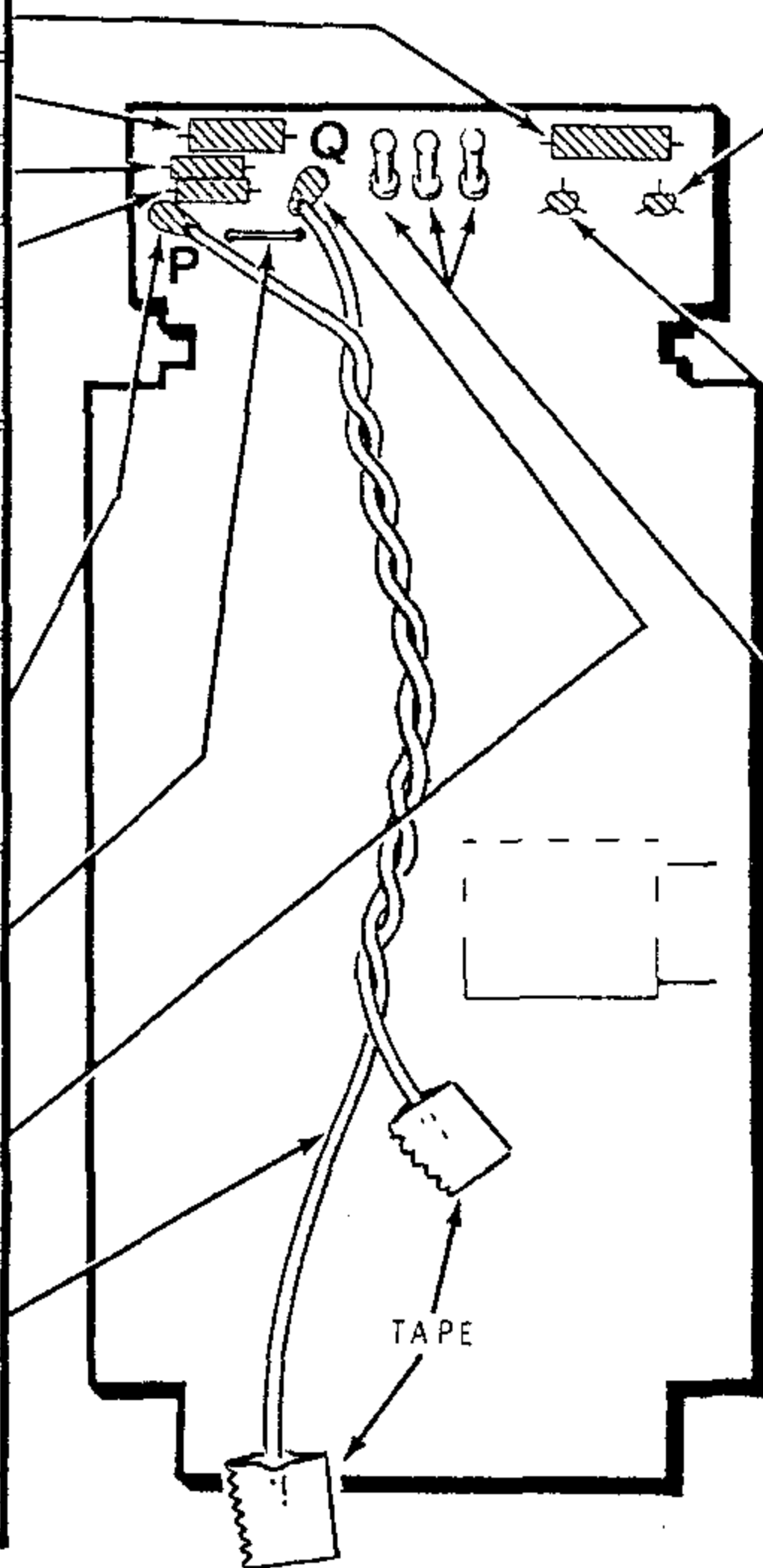
NOTE: When you prepare stranded wires, twist the bare ends and apply a small amount of solder to hold the strands together.

() Cut a 4" red wire, remove 1/8" of insulation from the wire ends, and install and solder the wire at P.

() From the remaining length of red wire, remove 1" of insulation. Then cut a single strand of wire and install and solder it at F1.

() Cut a 6" black wire, remove 1/8" of insulation from the wire ends, and install and solder the wire at Q.

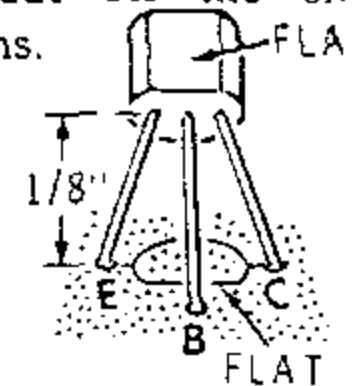
() Twist the red and black wires together as shown and place pieces of tape (not supplied) over the bare ends. Use masking, electrical, cellophane, or any other nonmetalized tape.



PICTORIAL 2-4

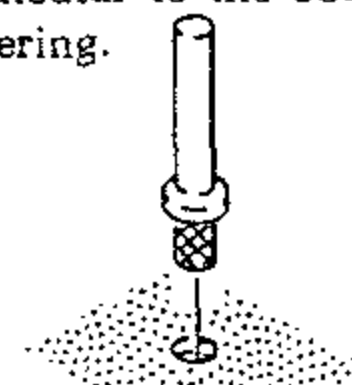
CONTINUE →

() Q2: 2N4121 transistor (#417-235). Solder the leads to the foil and cut off the excess lead lengths.



() Q3: 2N4121 transistor (#417-235). Solder the leads to the foil and cut off the excess lead lengths.

() Force three connector pins into their holes and solder them to the foil. Be sure each pin is perpendicular to the board before soldering.



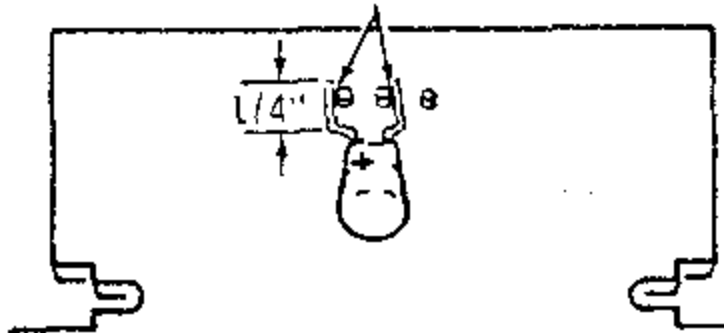
() Turn the circuit board right side up.

() C2: 33 μ F (33M) tantalum.

1. Cut both leads to 1/4".

2. Position the capacitor with the positive (+) or dot marked lead as shown.

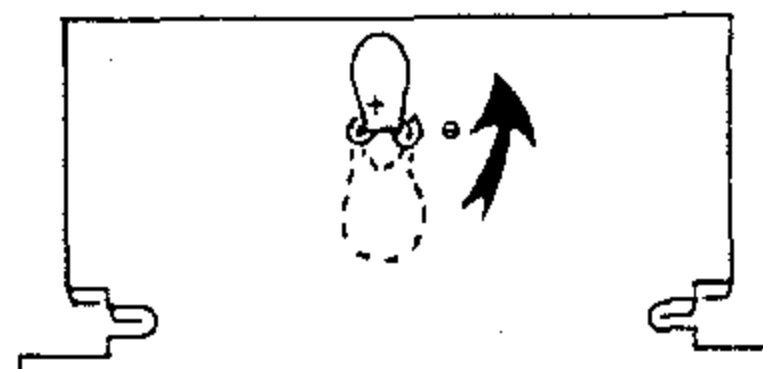
SOLDER

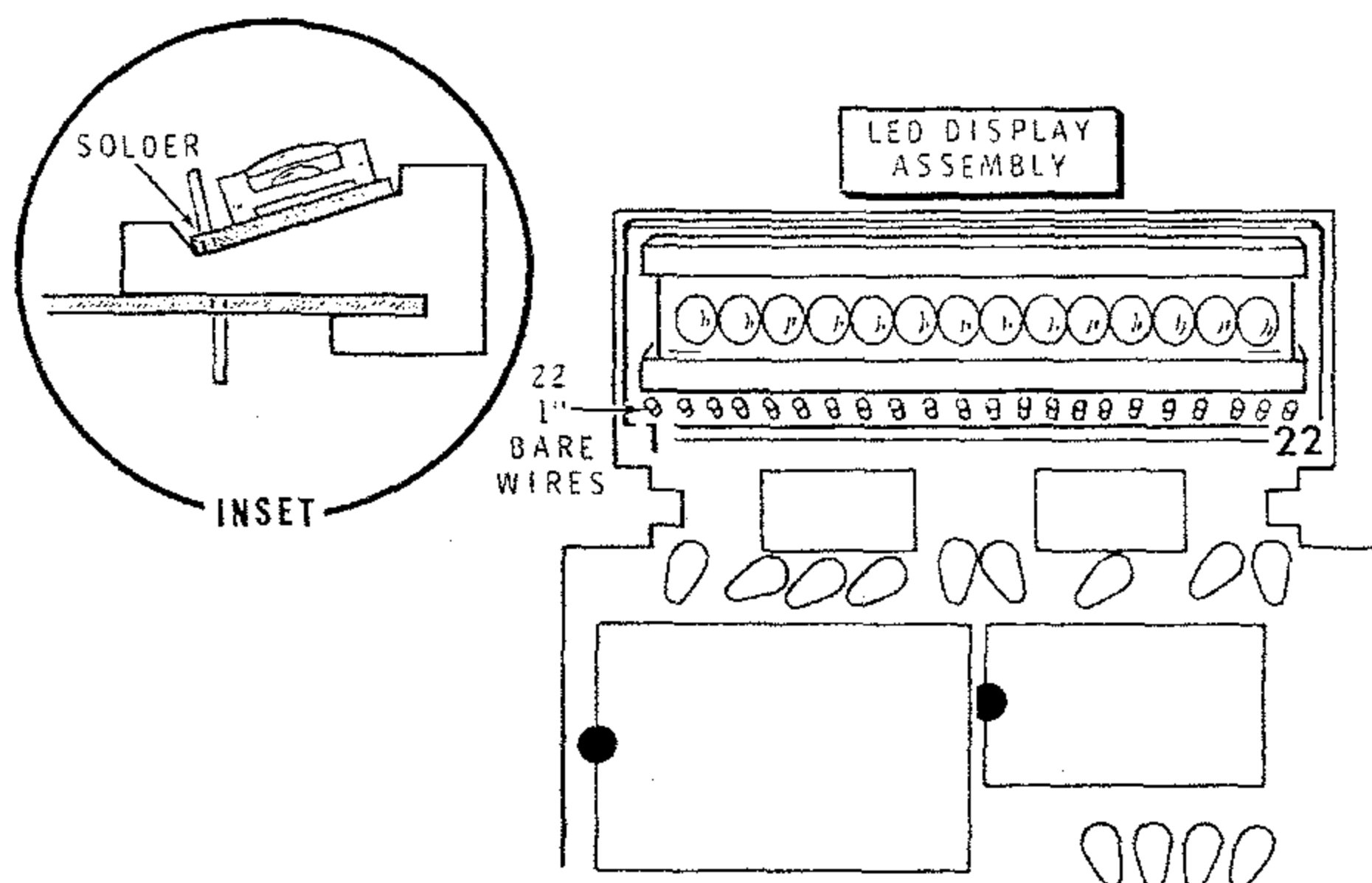


3. Solder the capacitor leads to the indicated connector pins.

4. Bend the capacitor up as shown. Be sure it does not extend beyond the edge of the circuit board.

5. Check the two connector pins to be sure they are still straight.





PICTORIAL 3-1

Refer to Pictorial 3-1 for the following steps.

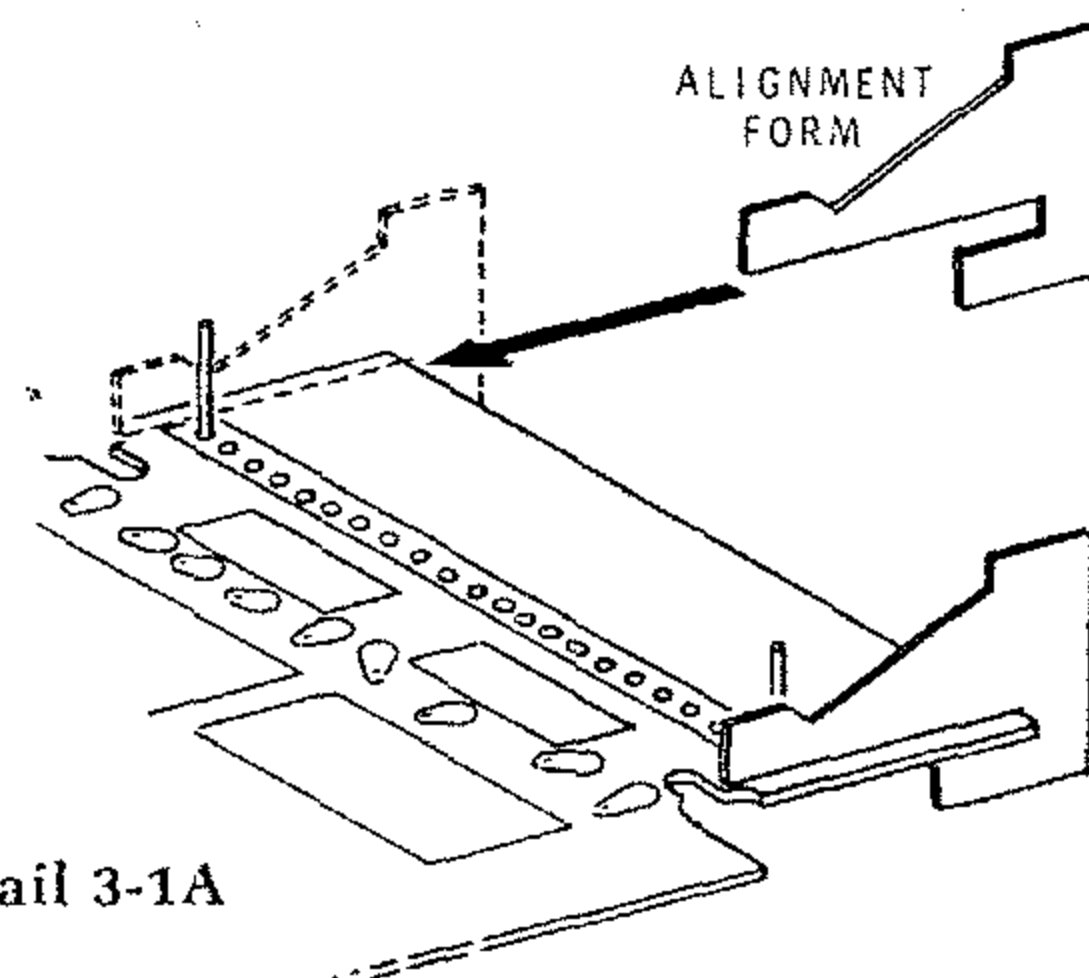
- () Read all the steps on this page. After you understand what is to be done, then perform the steps.
- () Locate the label set, and remove two alignment forms. Do NOT remove the protective backing from the alignment forms.

NOTE: You have two extra alignment forms in the label set. These forms will not be used.

- () Cut twenty-two 1" bare wires.
- () Refer to Detail 3-1A, turn the main circuit board right side up, if not already done, and install only two 1" bare wires in holes 1 and 22 as shown. Solder the wires to the foil.
- () Again refer to Detail 3-1A and slide the two alignment forms onto the circuit board as shown.

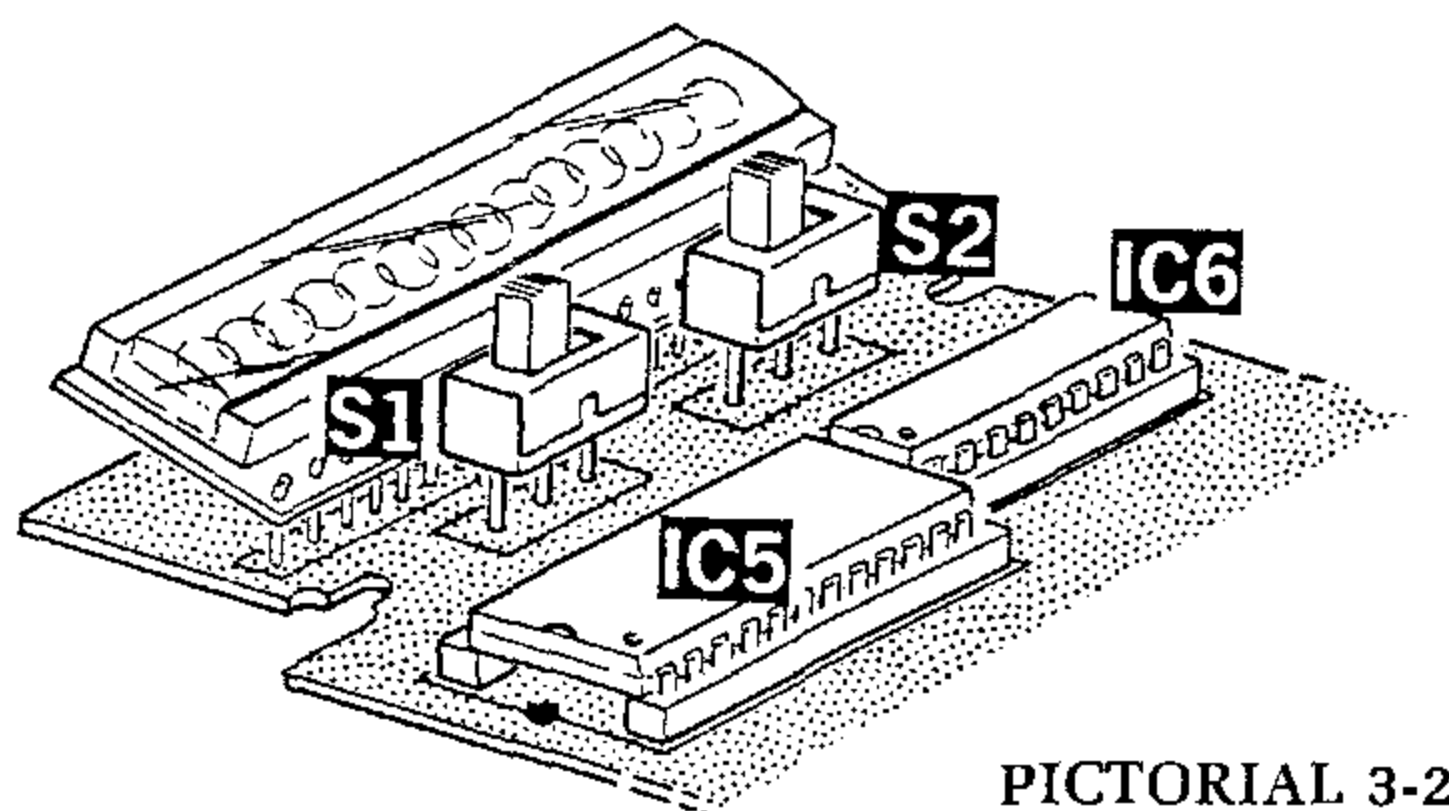
- () Refer to the inset drawing on Pictorial 3-1 and slide the LED display assembly onto the two bare wires, make sure the display is positioned properly on the alignment forms, and solder the wires to the display circuit board. Then cut off the excess wire lengths and remove the alignment forms.

- () Install and solder both ends of the remaining twenty 1" bare wires to the display and main circuit board. Then cut off the excess wire lengths.

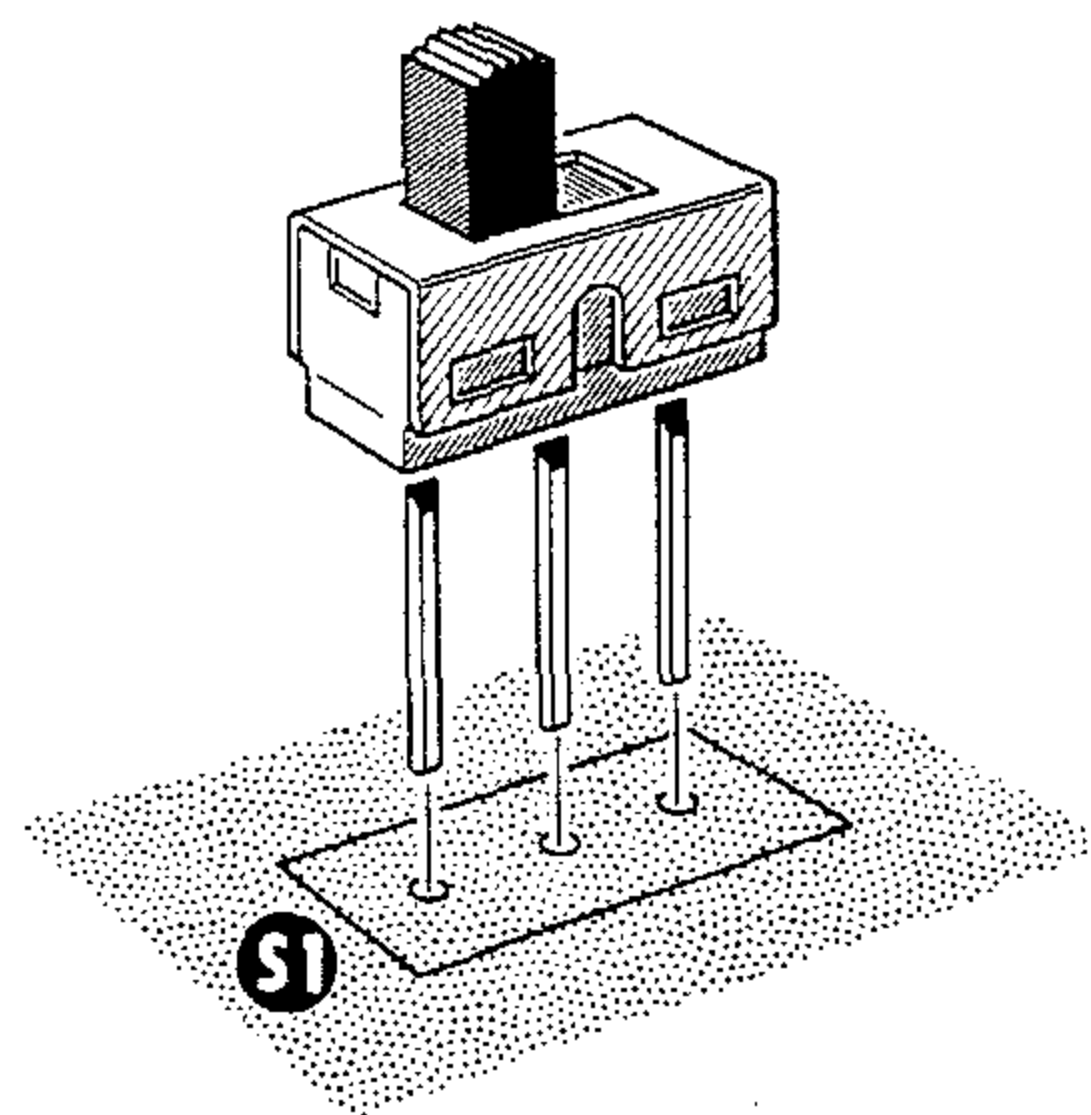


Detail 3-1A



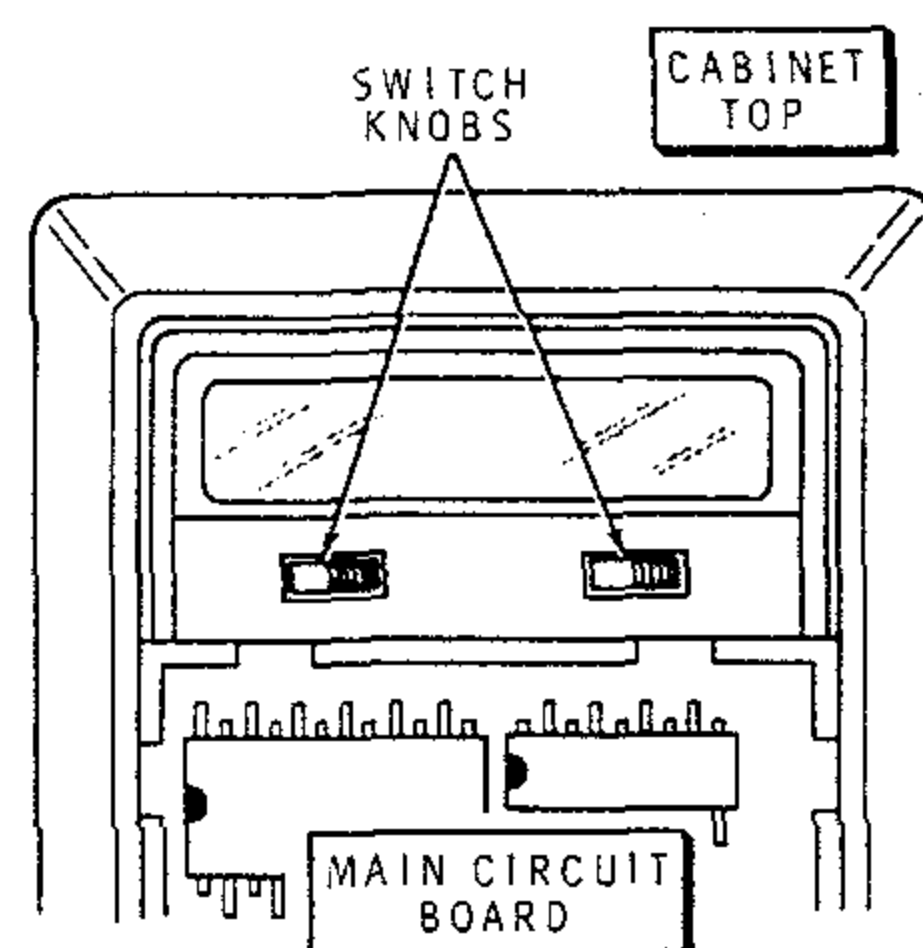


PICTORIAL 3-2

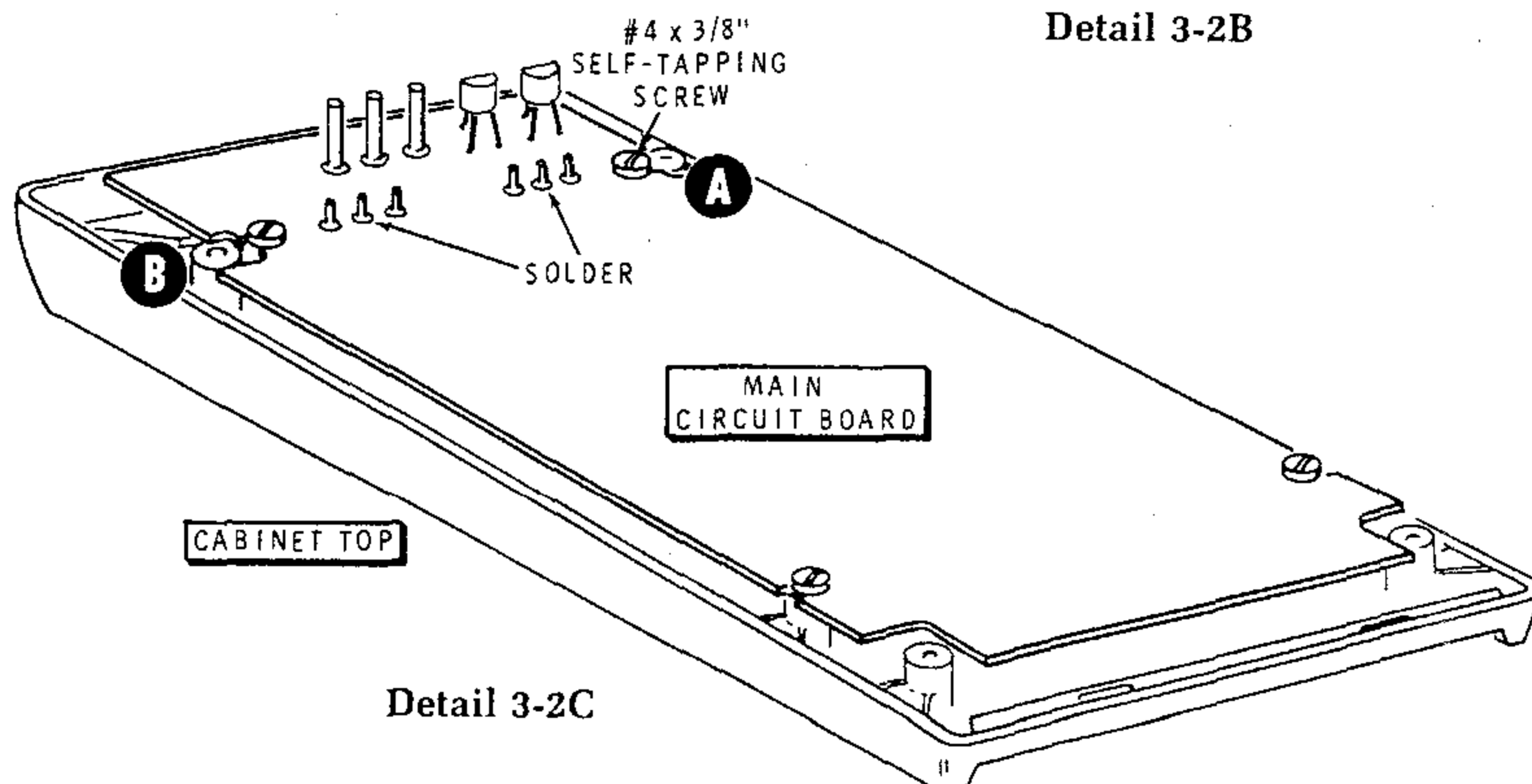


Detail 3-2A

- Refer to Pictorial 3-2 for the following steps.
- () Refer to Detail 3-2A and install a slide switch at SW1. Do not solder the lugs to the foil.
 - () In a similar manner, install a slide switch at SW2. Do not solder the lugs to the foil.
 - () Refer to Detail 3-2B and position the cabinet top as shown. Then push on the switch lugs until the knobs extend through the cutouts in the cabinet.
 - () Refer to Detail 3-2C, turn the cabinet over, and temporarily secure the circuit board to the cabinet top with four #4 × 3/8" self-tapping screws.
 - () Push on the switch lugs and move the switches as far into the cabinet top as they will go.
 - () Solder only the center lugs of both switches to the foil.



Detail 3-2B



Detail 3-2C



- () Operate the switches to be sure they operate freely. If they do not, reheat the soldered lugs and readjust the switches.
- () Also, refer to Detail 3-2D (in the Illustration Booklet, Page 2), and sight into the cabinet to be sure the switches are as far into the cabinet top as possible and are sitting straight.
- () Solder the remaining switch lugs to the foil.
- () Turn a #4 × 9/16" black screw all the way into hole A. (This prethreads the hole.) Then remove the screw.
- () In a similar manner, prethread hole B. Then set the screw aside.
- () Remove the four screws holding the circuit board and set the cabinet top aside.

NOTE: In the following steps, when you install an integrated circuit, refer to Detail 3-2E, and install the IC as shown.

- () IC6: Install a DS8867 (#443-846) 18-pin integrated circuit at IC6.

- () IC5: Install a DS8664 (#443-847) 24-pin integrated circuit at IC5.

NOTE: The remaining integrated circuits will be installed later.

CIRCUIT BOARD CHECKOUT

Carefully inspect the circuit board for the following conditions.

- () Unsoldered connections.
- () Poor solder connections.
- () Solder bridges between foils.
- () Protruding leads which could touch together.
- () Transistors and IC's for the proper type and installation.
- () Tantalum capacitor for the correct position of the positive (+) lead.

The pins on the ICs supplied with your kit are bent out at an angle as shown in Figure 1. DO NOT try to install them this way; it may damage the sockets, or cause intermittent connections that are very difficult to find later.

Therefore, before you install an IC, first be sure the pins are straight. Then lay it down on one of its rows of pins, as shown in Figure 2, and roll the IC over until the pins are at right angles or are bent in slightly as shown in Figure 3. Repeat this process for the other row of pins.

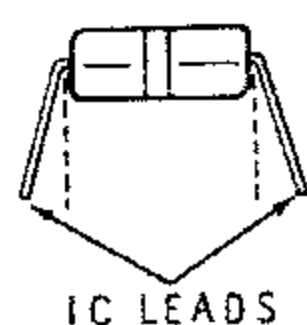


Figure 1

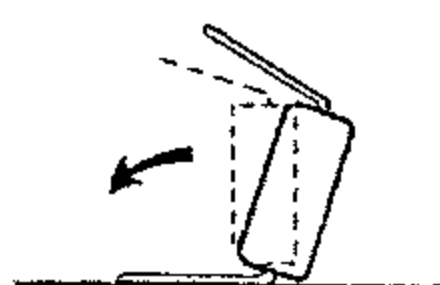


Figure 2

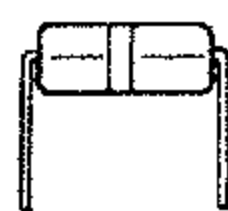
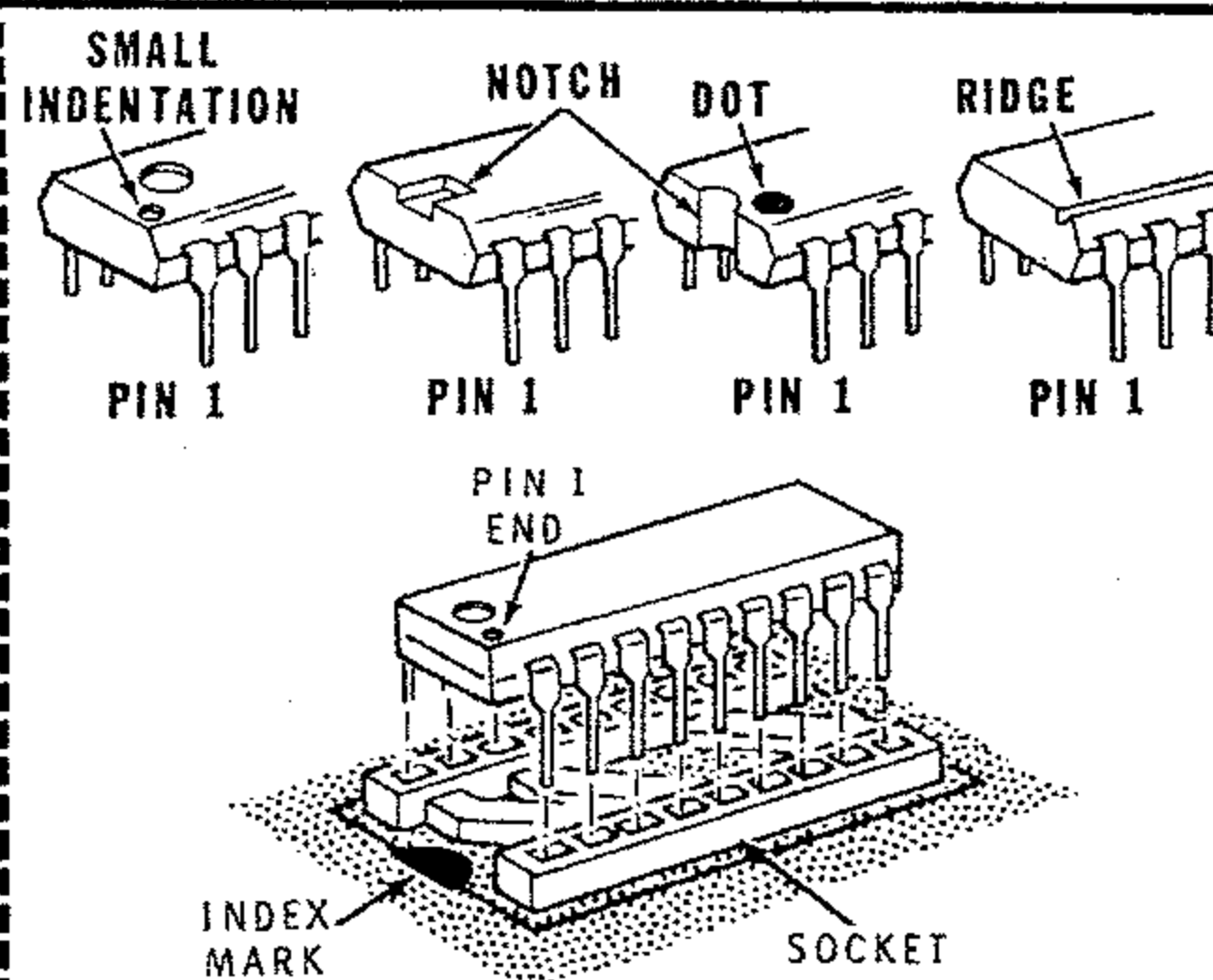
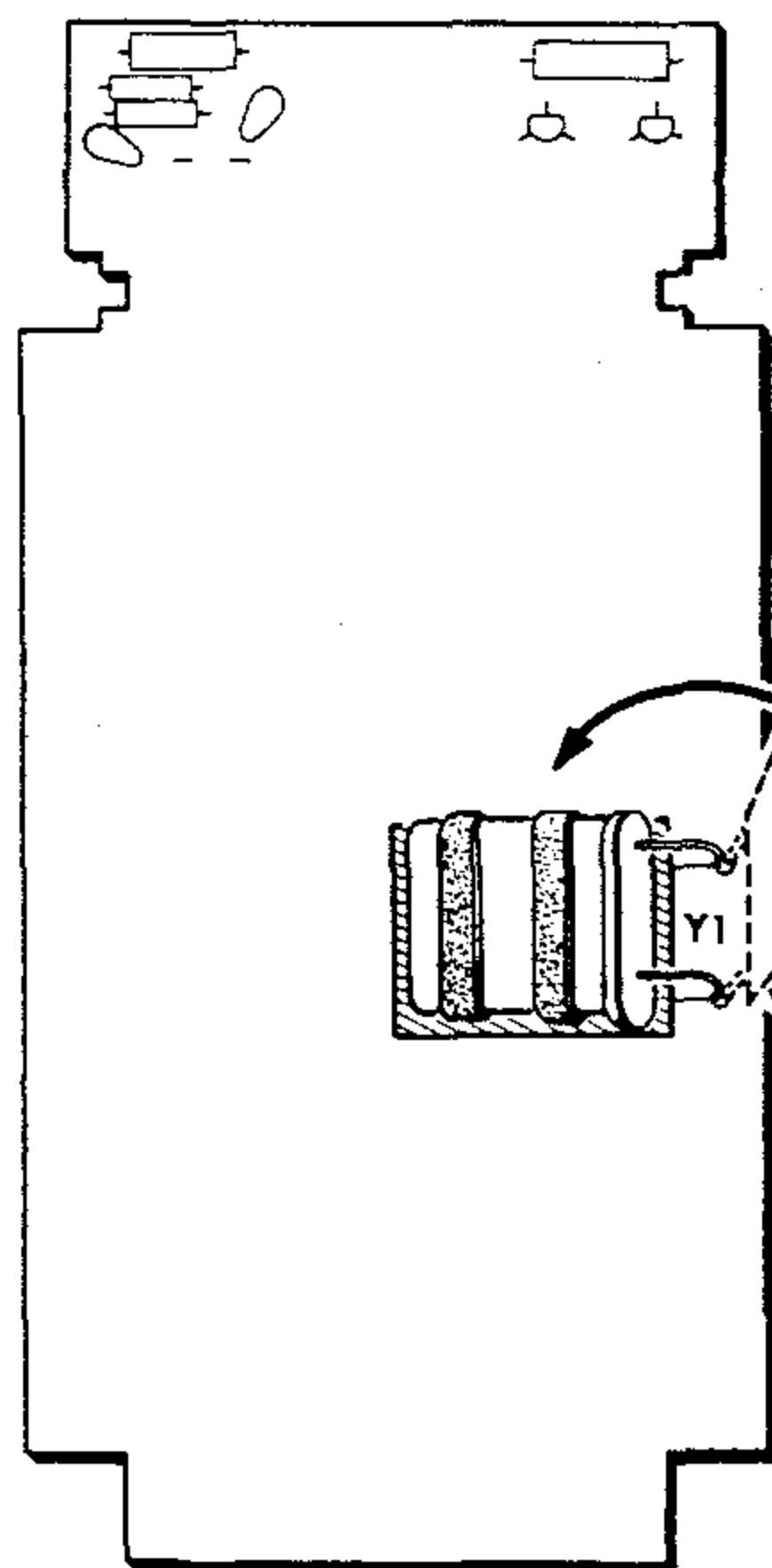


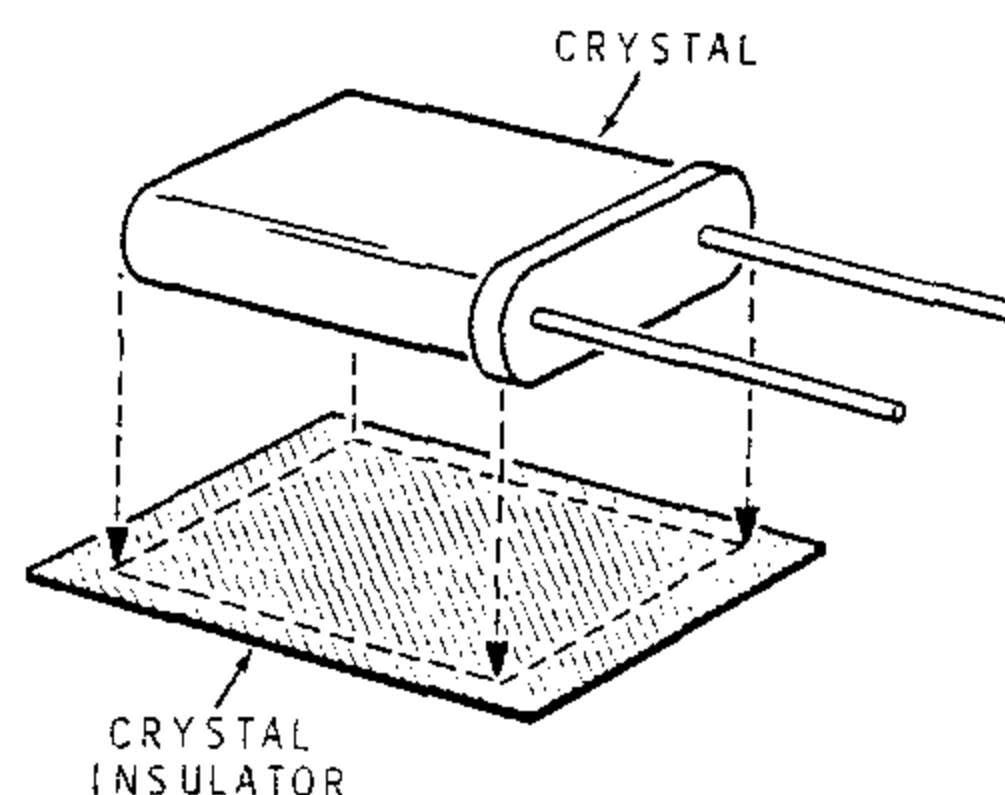
Figure 3



AFTER THE PINS ARE STRAIGHTENED, POSITION THE PIN 1 END OF THE IC AT THE END OF THE SOCKET WHERE THE INDEX MARK IS SCREENED ON THE CIRCUIT BOARD. THEN INSERT THE IC PINS INTO THE SOCKET AND PUSH THE IC DOWN INTO PLACE. BE SURE YOU DO NOT BEND OVER ANY IC PINS. THIS IS VERY EASY TO DO.



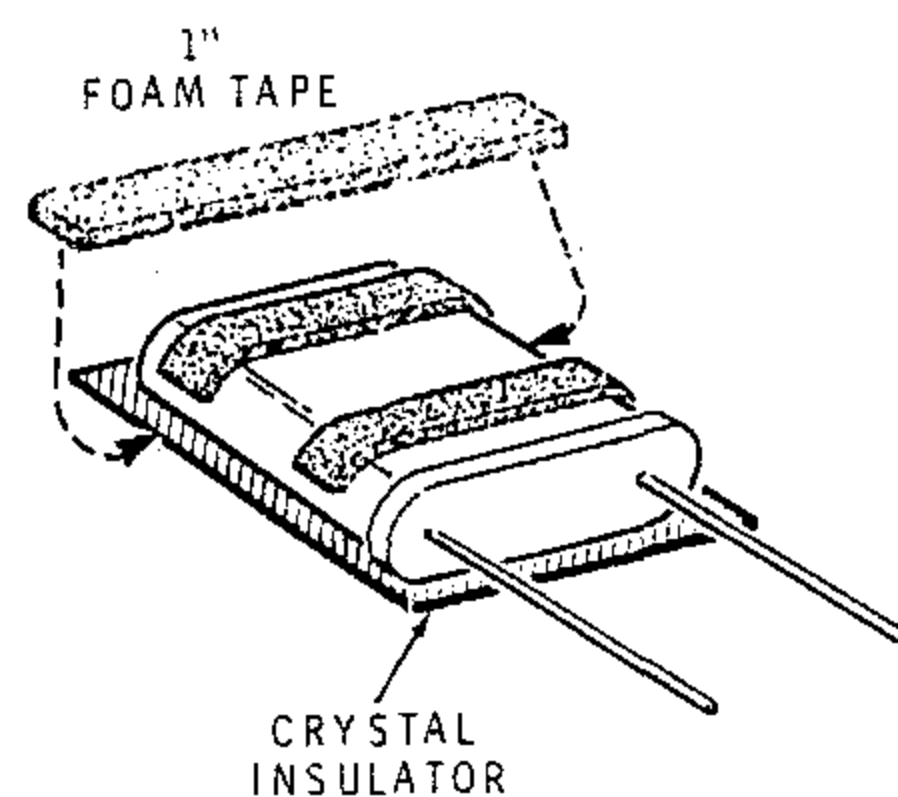
PICTORIAL 3-3



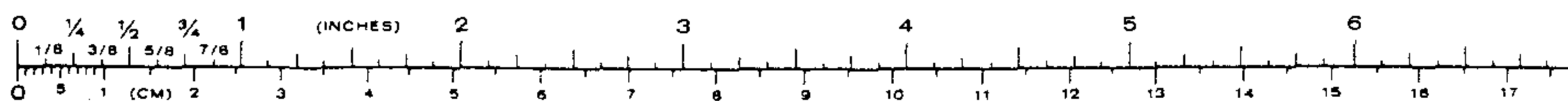
Detail 3-3A

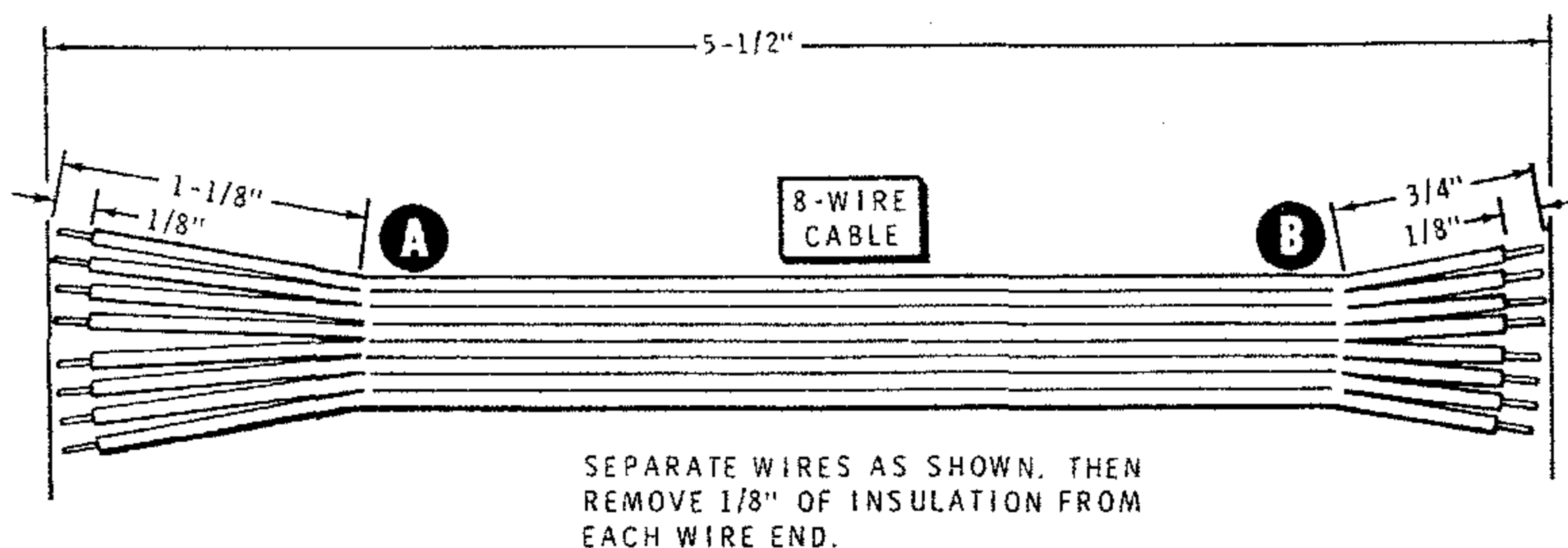
Refer to Pictorial 3-3 for the following steps.

- () Refer to Detail 3-3A, remove the crystal insulator from the label set, and press the insulator onto the crystal as shown.
- () Cut two 1" lengths of foam tape.
- () Refer to Detail 3-3B, remove the protective backing from the lengths of foam tape and apply the tape to the crystal as shown.
- () Install the crystal on the bottom of the main circuit board as shown and solder its leads to the foil. Cut off the excess lead lengths.



Detail 3-3B





Detail 3-4A

Refer to Pictorial 3-4 (Illustration Booklet, Page 2) for the following steps.

NOTE: The following cables are shown actual size in the Details.

- () Cut a 5-1/2" length of 8-wire cable and prepare it as shown in Detail 3-4A. NOTE: When you prepare stranded wires, twist the bare ends and apply a small amount of solder to hold the strands together.

- () Position the keyboard as shown in the Pictorial.

In the following steps, connect end B of the 8-wire cable to the keyboard. Insert the bare end of each wire part way into the circuit board hole and then solder the connection. Lightly tug on the wire to be sure it is soldered.

- () Gray.
- () Violet.

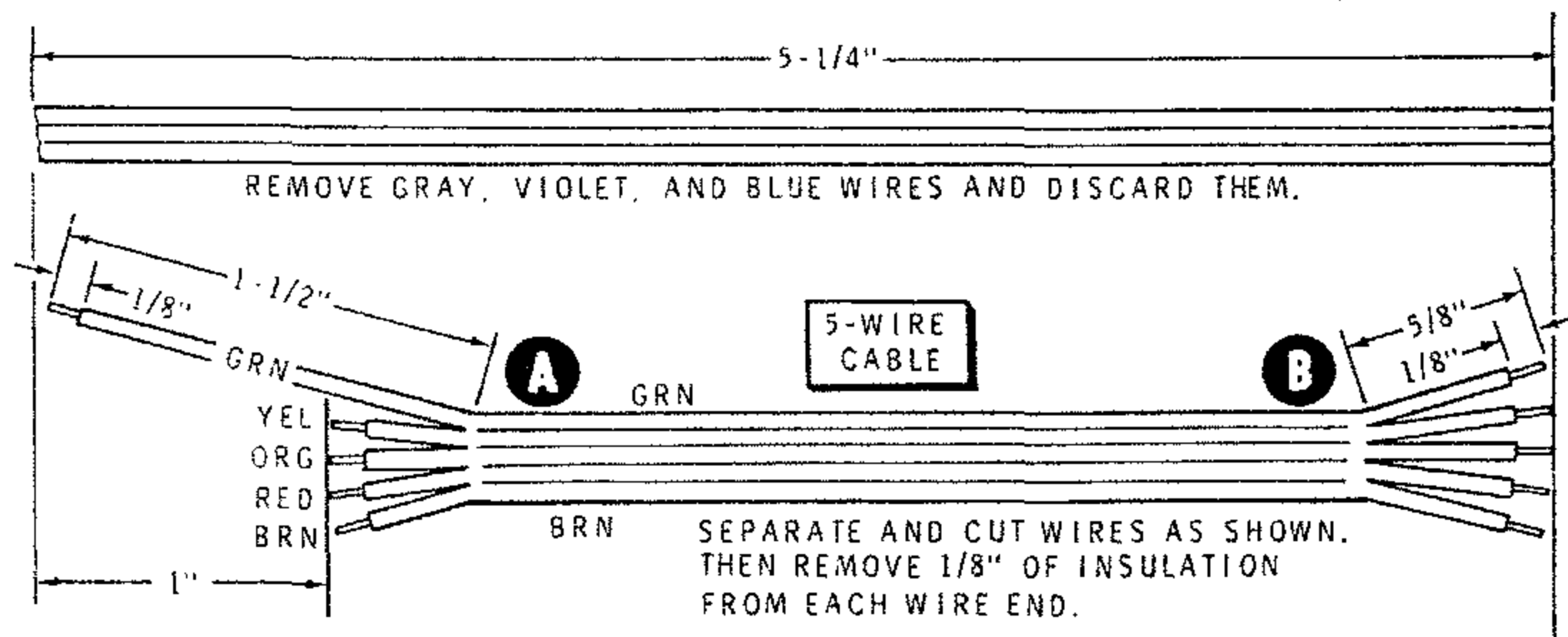
- () Blue.
- () Green.
- () Yellow.
- () Orange.
- () Red.
- () Brown.

- () Cut a 5-1/4" length of 8-wire cable and prepare a 5-wire cable as shown in Detail 3-4B.

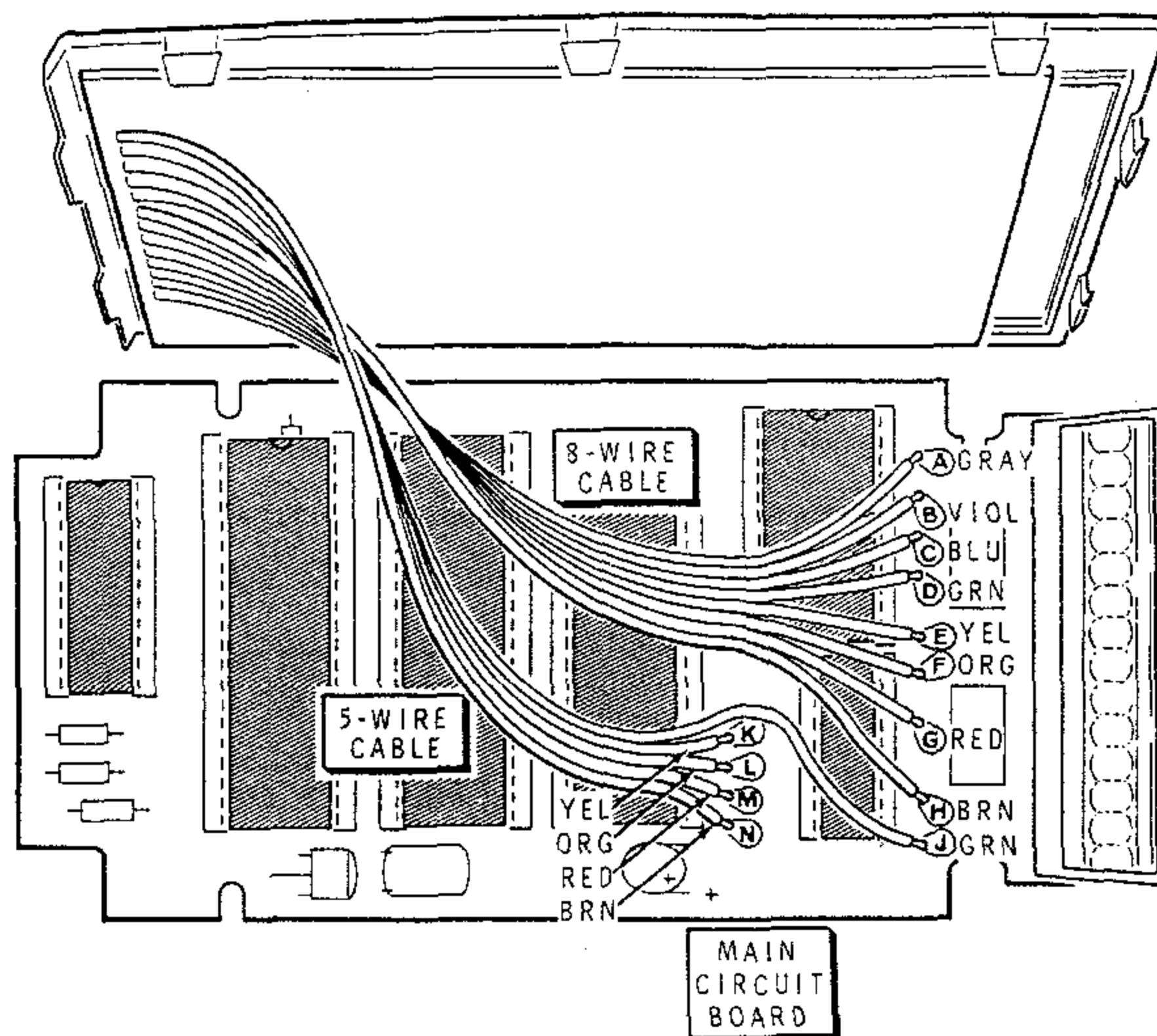
In the following steps, as before, connect end B of the 5-wire cable to the keyboard.

- () Green.
- () Yellow.
- () Orange.
- () Red.
- () Brown.

- () Bend all the wires down flat on the circuit board as close to the holes as possible.



Detail 3-4B



PICTORIAL 3-5

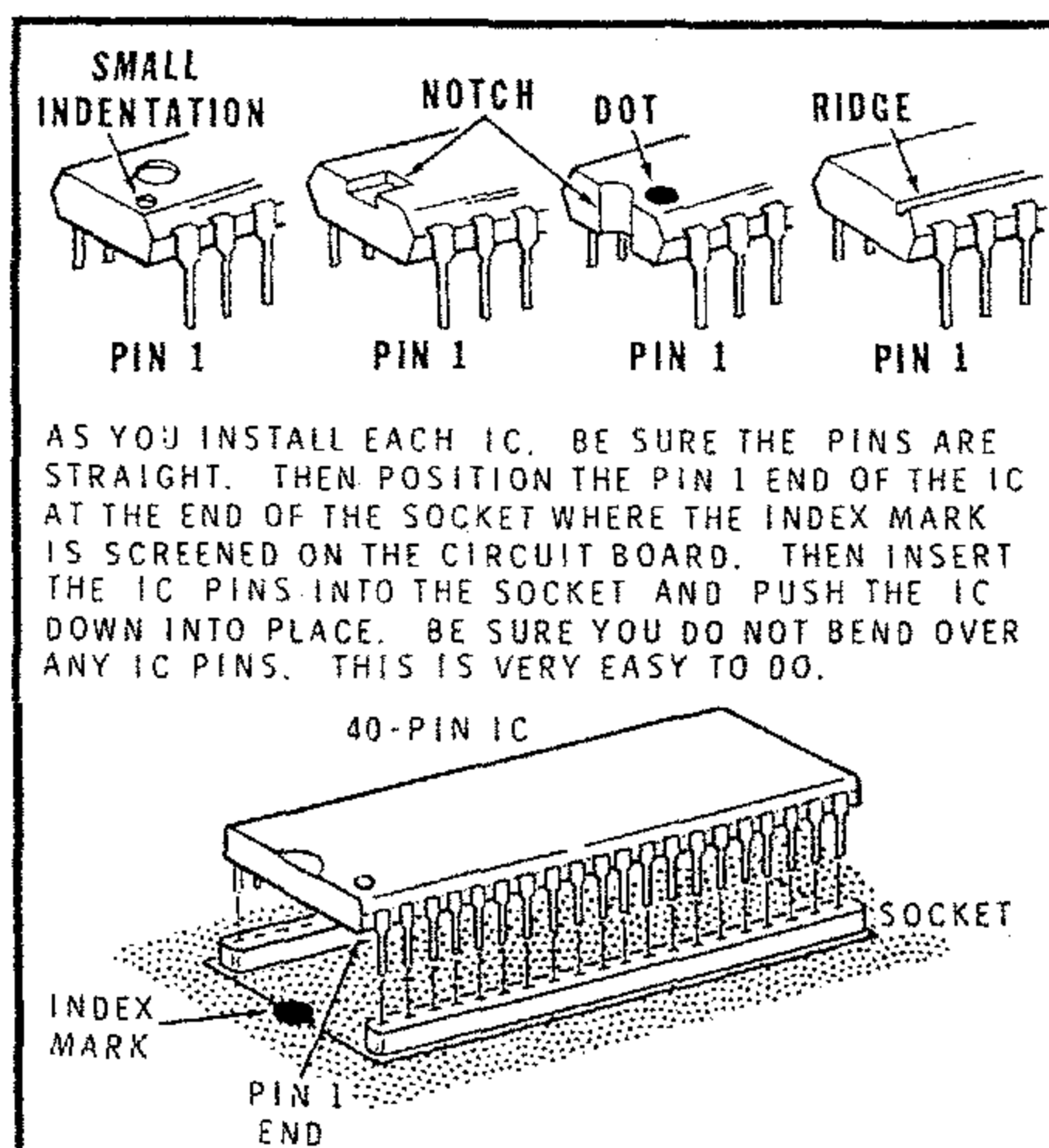
Refer to Pictorial 3-5 for the following steps.

Connect the wires at the free end of the 8-wire cable to the main circuit board holes as follows. Solder each wire as you install it.

- () Gray to hole A.
- () Violet to hole B.
- () Blue to hole C.
- () Green to hole D.
- () Yellow to hole E.
- () Orange to hole F.
- () Red to hole G.
- () Brown to hole H.

Connect the wires at the free end of the 5-wire cable to the main circuit board holes as follows. Solder each wire as you install it.

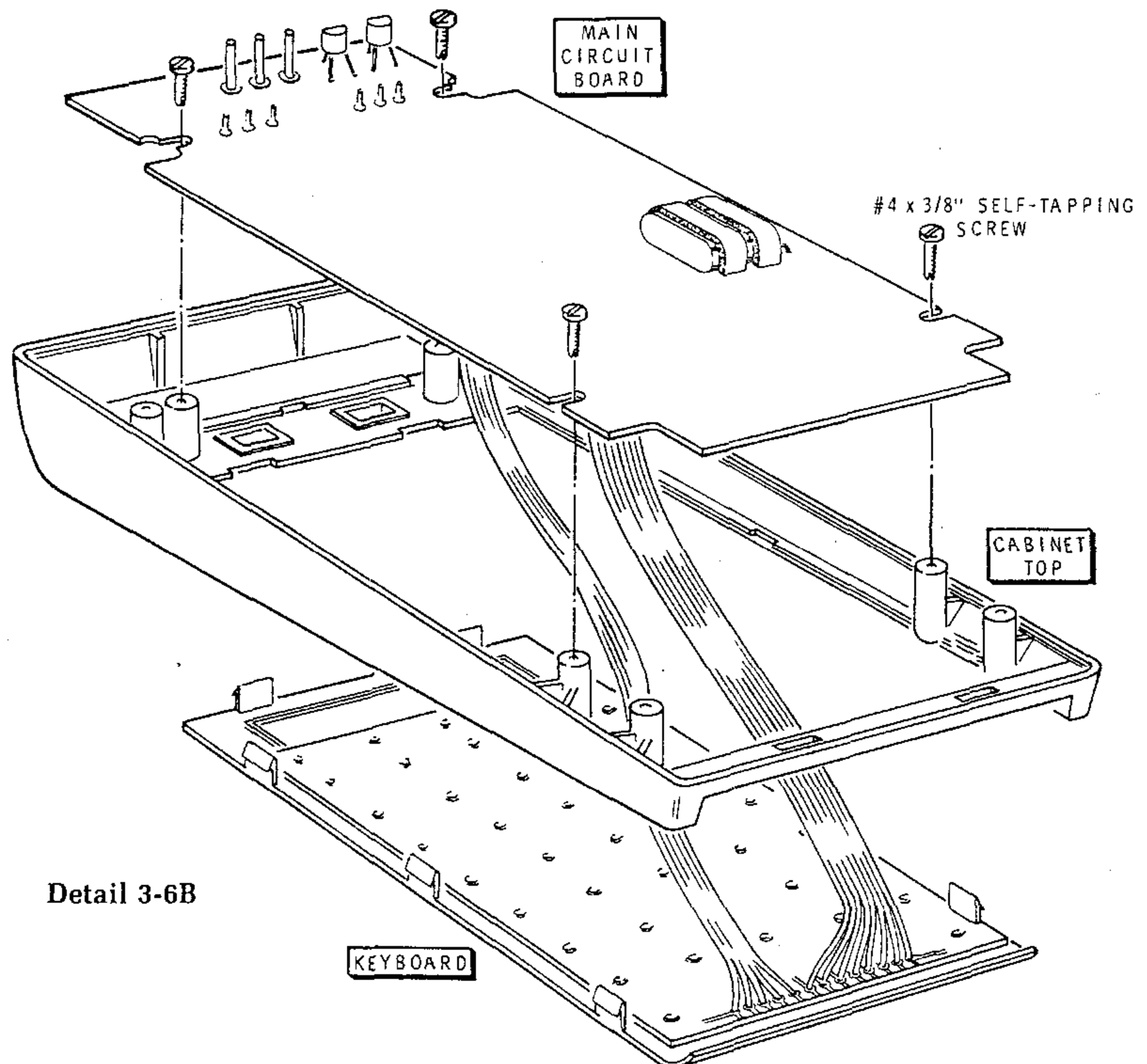
- () Yellow to hole K.
- () Orange to hole L.
- () Red to hole M.
- () Brown to hole N.
- () Green to hole J.



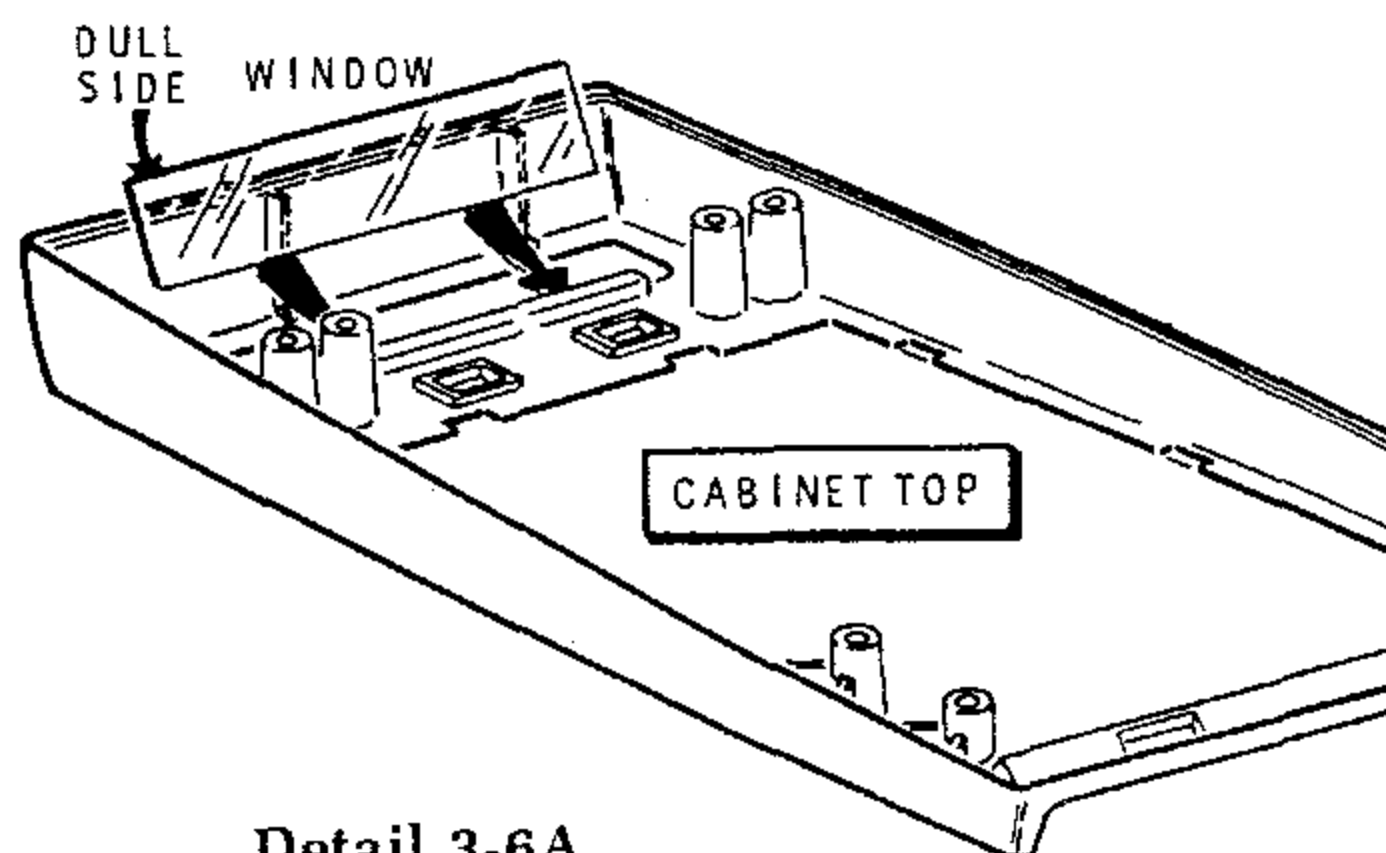
Detail 3-5A

The following integrated circuits are packed in conductive foam or protective carriers. These IC's are rugged and reliable components. However, normal static electricity discharged from your body through an IC pin to an object can damage the IC. Install these IC's without interruption as follows:

1. Remove the IC from its package with both hands.
 2. Hold the IC with one hand and straighten any bent pins with the other hand.
 3. Refer to Detail 3-5A. Then position the pin 1 end of the IC over the index mark on the circuit board.
 4. Be sure each IC pin is properly started into the socket. Then push the IC down.
- () IC4: Install a 40-pin integrated circuit (#444-14) at IC4.
- () IC3: install a 40-pin integrated circuit (#444-15) at IC3.
- () IC2: Install a 40-pin integrated circuit (#444-16) at IC2.
- () IC1: Install a 3539 22-pin integrated circuit (#443-845) at IC1.



Detail 3-6B

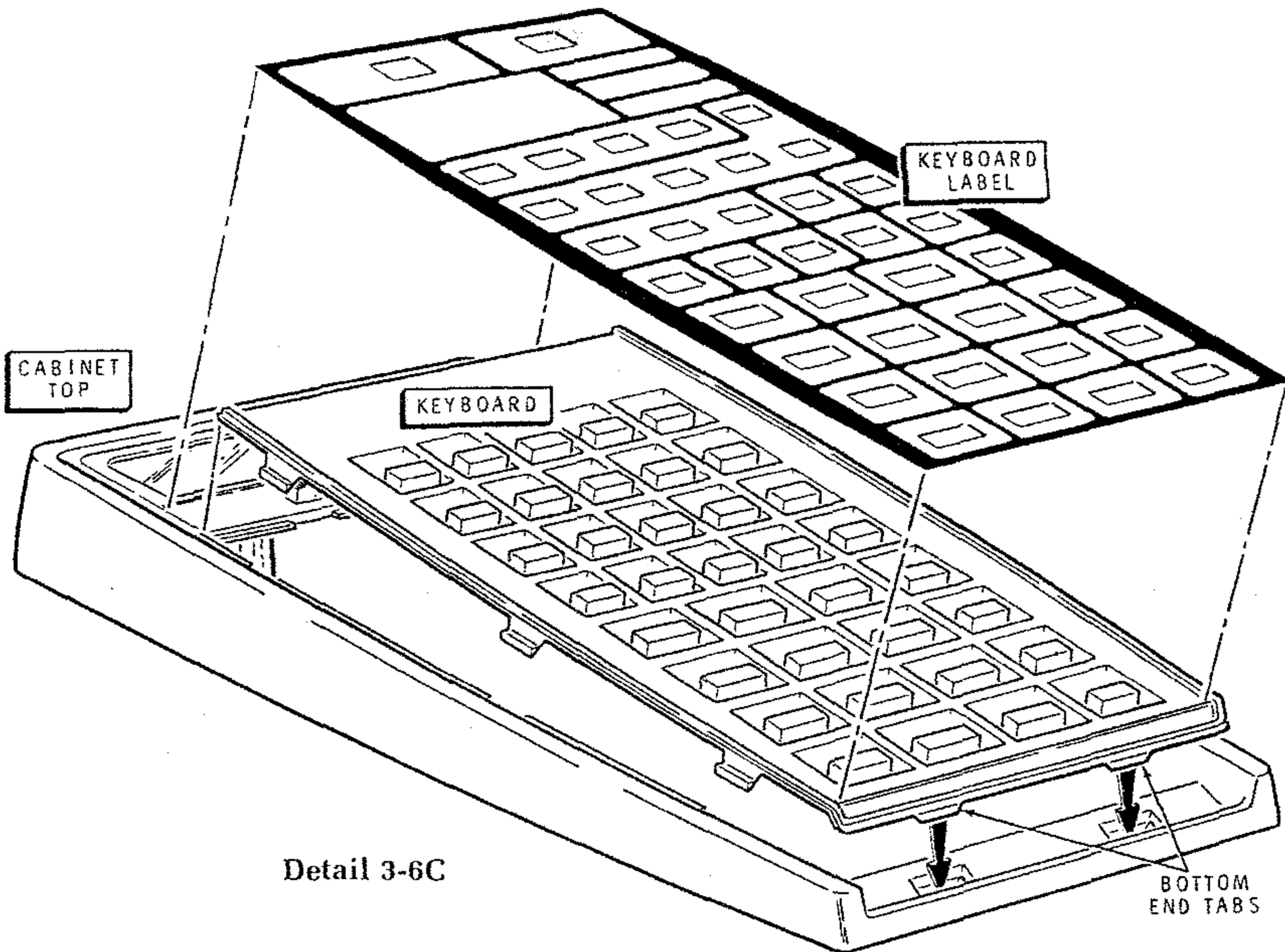


Detail 3-6A

Refer to Pictorial 3-6 (Illustration Booklet, Page 2) for the following steps.

NOTE: The window supplied in your kit may or may not be covered with a protective plastic coating. If it has such a coating, be sure to remove it (from both sides) before you install the window in the next step.

- () Refer to Detail 3-6A and install the window in the cabinet top (dull side down) as shown.
- () Refer to Detail 3-6B and insert the keyboard through the cabinet top; carefully position the main circuit board into place, and secure it to the cabinet top with four #4 \times 3/8" self-tapping screws.



Detail 3-6C

- () Refer to Detail 3-6C and install the keyboard into the cabinet top. Insert the bottom end tabs first; then press the other keyboard tabs down into place as you work your way toward the display end of the cabinet. The tabs will go in hard and click into place.

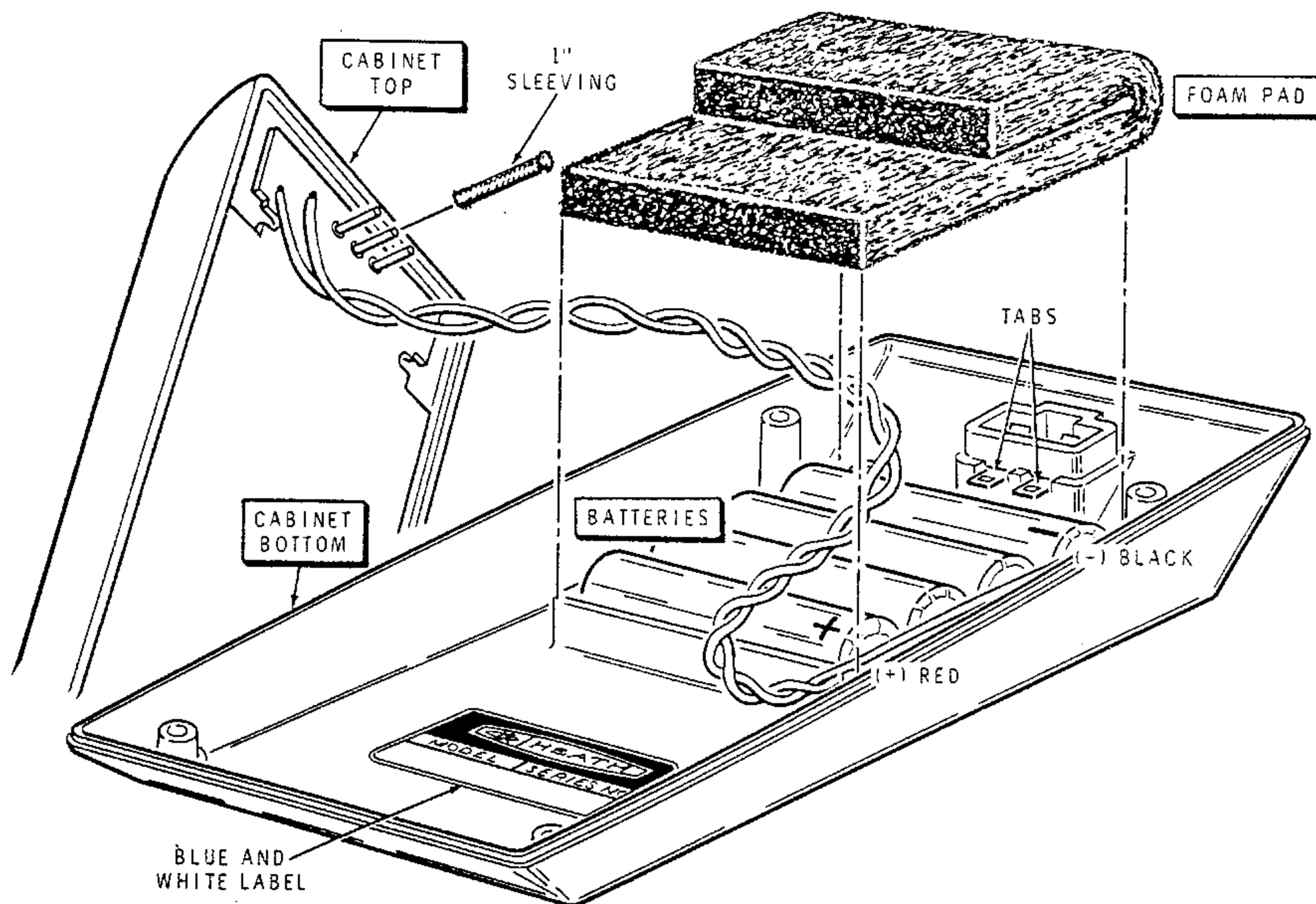
NOTE: In the next step, you will apply one of the two keyboard labels onto the keyboard. One label omits math functions not normally used in navigation (logarithms, trigonometry, etc.). Compare the two labels and select the one you want to use. If necessary, refer to the "Operation" section for a discussion of the functions.

- () Again refer to Detail 3-6C and carefully apply the selected keyboard label to the keyboard and cabinet top. First, if necessary, remove the cut-out portions of the label. Then remove the protective backing and apply the label.
- () Refer to the Pictorial and place the POWER switch to OFF, and the STANDBY switch to NORMAL.

- () Plug the AC charger into an AC outlet.
- () Refer to the inset drawing and plug the AC charger into your Computer. Be sure the charger connector is positioned as shown.

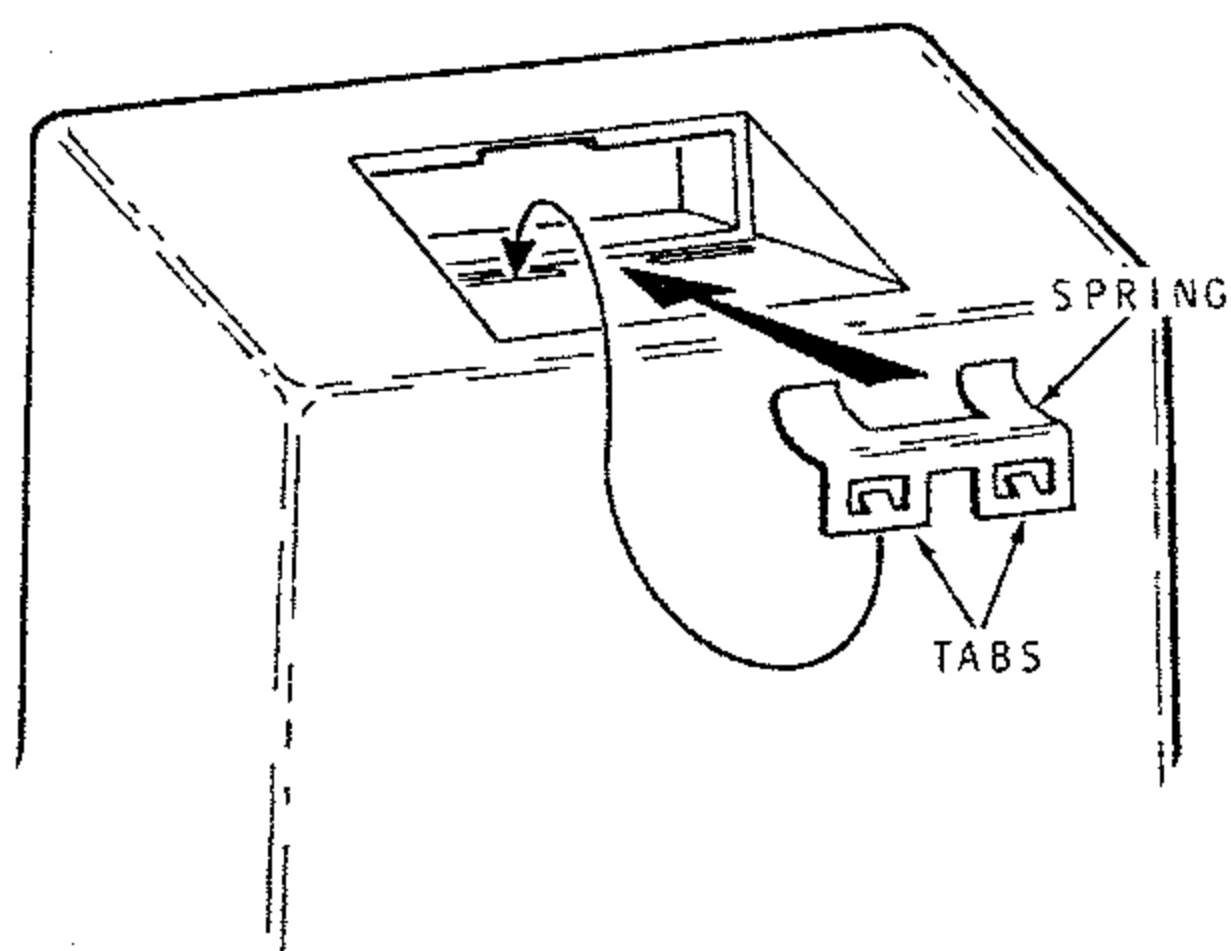
NOTE: If you do not obtain the proper results in the next step, turn the POWER switch to OFF and then to ON again. If you still do not obtain the proper results, unplug the AC charger and proceed to "In Case of Difficulty" on Page 93.

- () Push the STANDBY switch to NORMAL and the POWER switch to ON. The display should first indicate OC-1401. Then the displayed information will move from left to right and the final display will be 0.00.
- () Push the POWER switch to OFF and unplug the AC charger from the Computer.

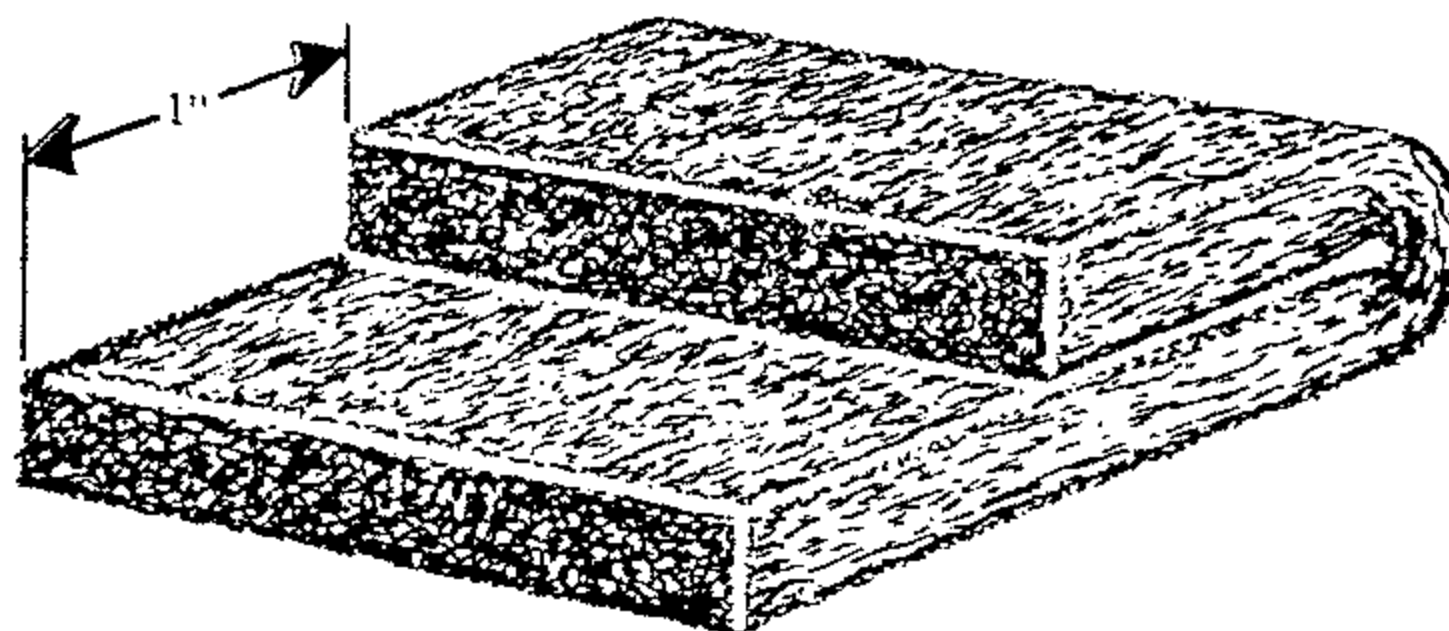


PICTORIAL 3-7





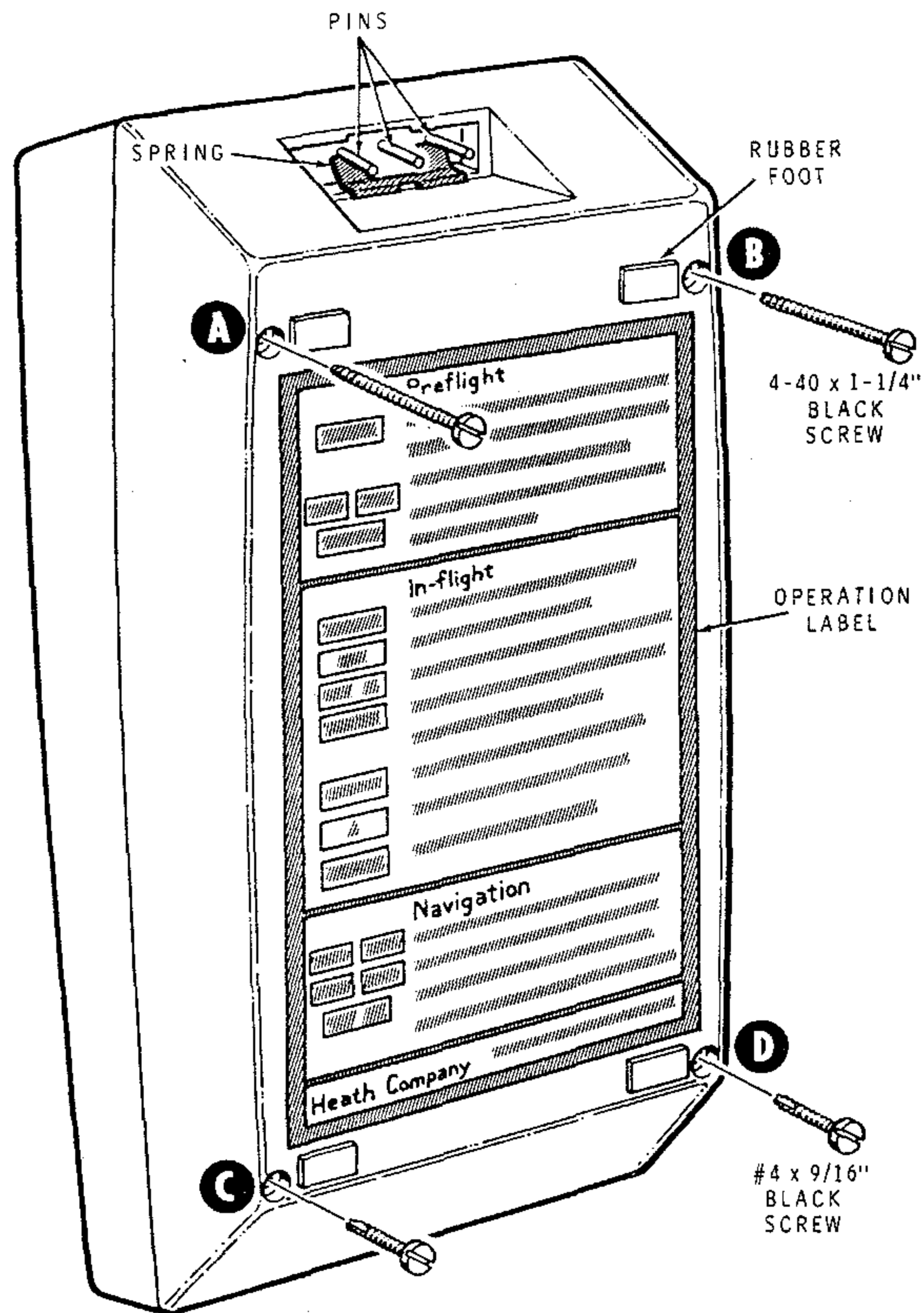
Detail 3-7A



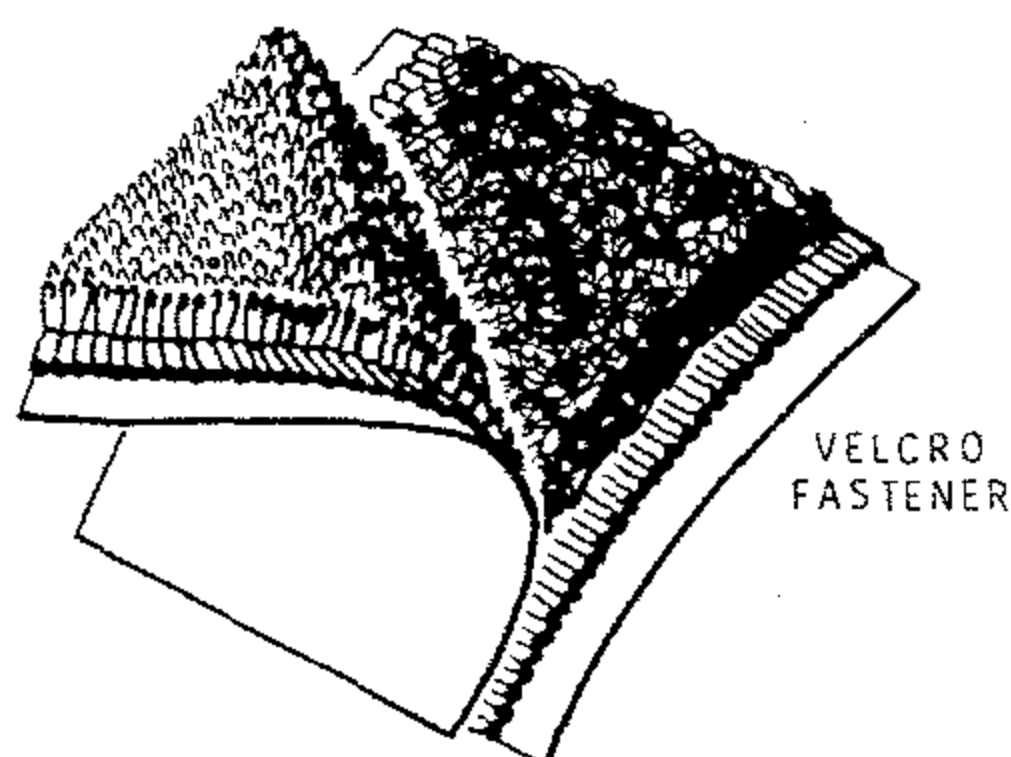
Detail 3-7B

Refer to Pictorial 3-7 for the following steps.

- () Refer to Detail 3-7A, turn the cabinet bottom over, and install the spring in the cabinet bottom. Be sure the tabs lock in place.
- () If not already done, remove the sun shield from inside the cabinet bottom.
- () Remove the backing paper from the blue and white label. Press the label onto the inside of the cabinet bottom. Be sure to refer to the numbers on this label in any communications you might have with the Heath Company about this kit.
- () Place a 1" length of sleeving over the center circuit board pin in the cabinet top. This will prevent accidental short circuits when you put the cabinet parts together.
- () Remove the tape from the red and black wire ends.
- () Connect the black wire to the minus (-) battery lug. Do not put the batteries into the cabinet yet.
- () Connect the red wire to the plus (+) battery lug.
- () Place the batteries into the cabinet bottom and route the wires as shown. Bend the tabs as necessary to let the batteries fit properly in the cabinet.
- () Refer to Detail 3-7B and fold the foam pad as shown. Then place it on top of the batteries.



PICTORIAL 3-8

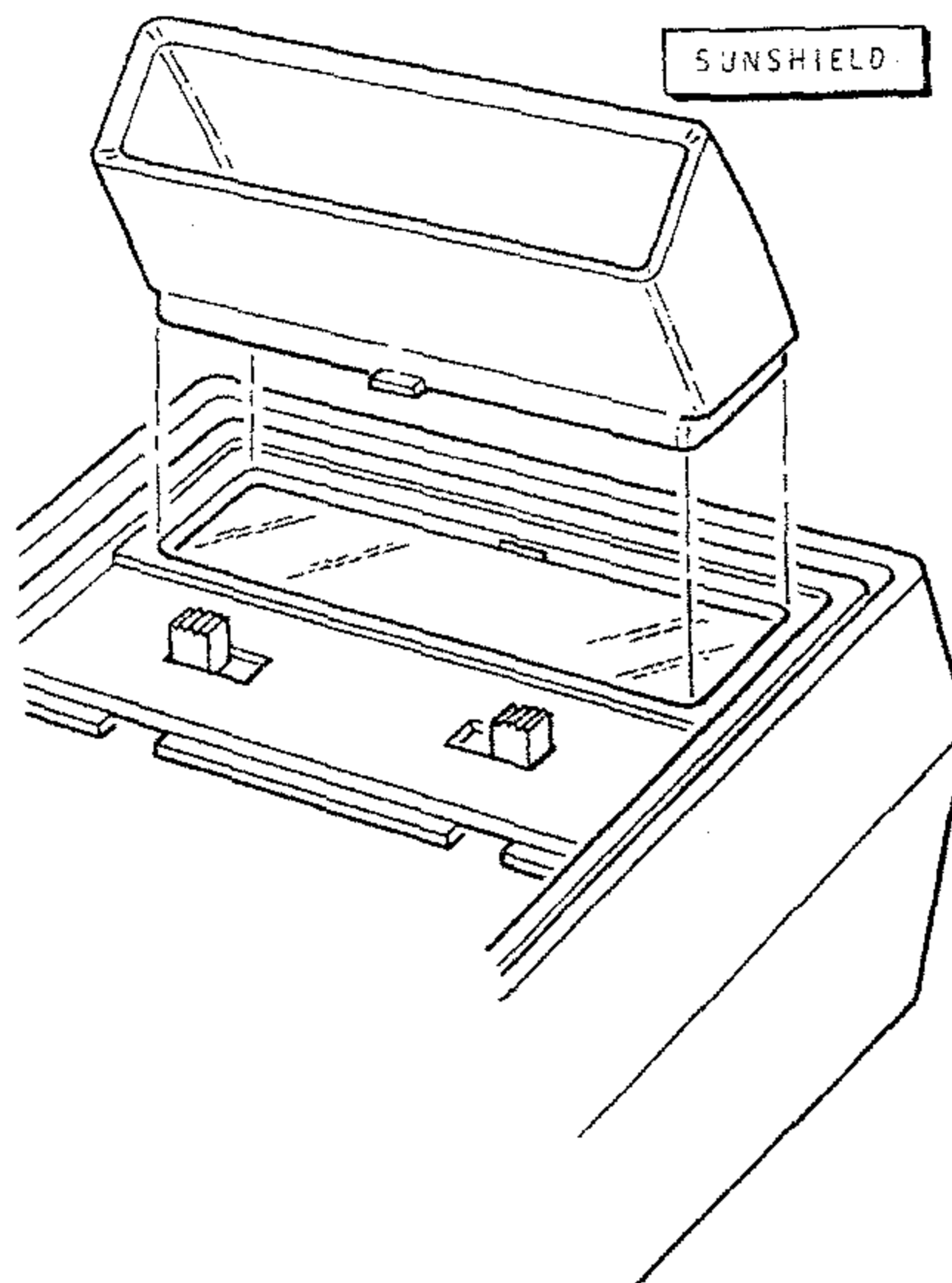


Detail 3-8A

Refer to Pictorial 3-8 for the following steps.

- () Place the cabinet top and bottom together. (Be sure the connector pins and spring are positioned as shown.) Install two 4-40 \times 1-1/4" black screws at A and B, and two #4 \times 9/16" black screws at C and D.
- () Remove the length of sleeving from the center pin.
- () Remove the protective backing from the four rubber feet and press the feet in place as shown.
- () Remove the operation label from the label set and press the label in place as shown.

NOTE: You have two Velcro fasteners remaining. If you want to attach your Computer or charger to something, use the fasteners as necessary to do this. Each fastener is made of two sticky-backed parts which separate as shown in Detail 3-8A.



PICTORIAL 3-9

- () Refer to Pictorial 3-9 and attach the sun shield. NOTE: The sun shield is not normally needed. However, in extremely bright light, you may want to use it.

This completes the assembly of your kit. Proceed to the "Operation" section.



OPERATION

This section of the Manual explains the operation of your Aircraft Navigation Computer. Read the features and operating procedures so you will become familiar with your Computer. The purpose of the example calculations in this section is to demonstrate the operation of the Computer.

FAMILIARIZATION

The purpose of the following paragraphs is to acquaint you with the basic operation of your Computer.

To begin:

1. Make sure the NORMAL-STANDBY switch is in the NORMAL position.
2. Slide the OFF-ON switch to ON.

DISPLAY

Numbers that you key into the computer and intermediate and final answers always appear in the bright red display. When you first turn the Computer on, the display first indicates 00-1401. Then the displayed information will move from left to right and 0.00 will appear in the display. This shows you that the Computer is "cleared."

CLEARING

You can clear any numbers that are in the display by pressing CLAX (clear x). This key erases the number in the display and replaces it with 0.00.

Press

CLAX

Display

0.00

If you make a mistake while you key in a number, clear the complete displayed number by pressing CLAX. Then key in the correct number.

KEYBOARD

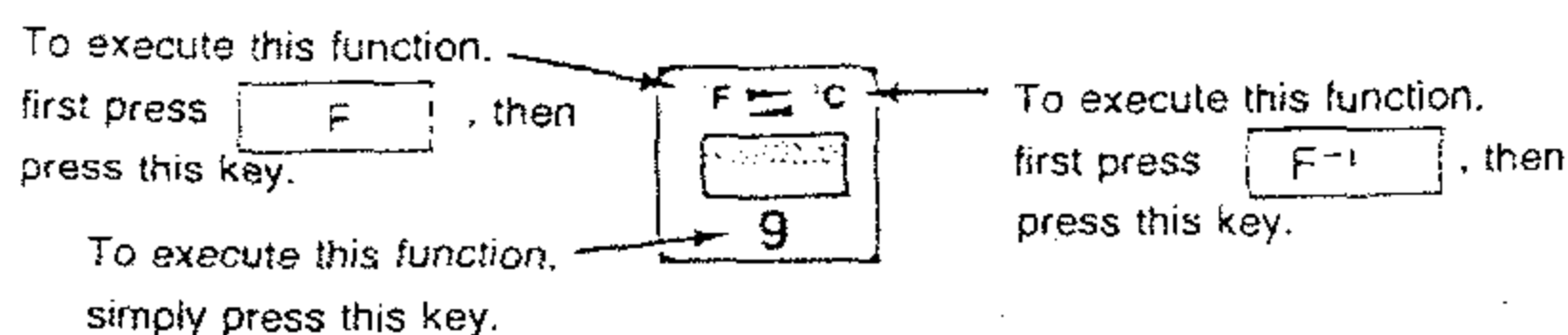
There are two prefix keys, F and F⁻¹. If you press one of these prefix keys before you press a function key, you select one of the functions printed in green or brown **above** the function key.

To select the function printed in black below the function key, press the key. (NOTE: No prefix key is pressed).

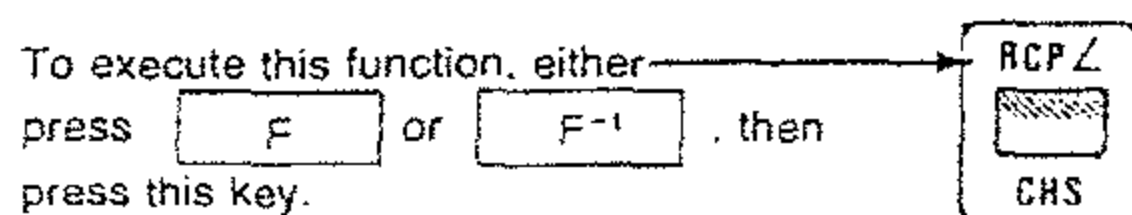


To select the function printed in green above the function key, press the green \boxed{F} prefix key. Then press the function key.

To select the function printed in brown above the function key, first press the brown $\boxed{F^{-1}}$ prefix key. Then press the function key.



NOTE: In several instances there is only a single function printed above the function key. Although these functions are printed in green and are always listed as \boxed{F} functions in this Manual, they may be either \boxed{F} or $\boxed{F^{-1}}$.



CLEARING PREFIX

If you key in a number and then press the wrong prefix key, you can clear the prefix by pressing the $\boxed{CLA\ PRE}$ (clear prefix) key. Then continue with the proper procedure.

KEYING IN NUMBERS

To key in numbers, press the number keys in sequence, just as if you were writing the numbers on a piece of paper. Note that the decimal point must be keyed in if it is part of the number unless it is to the right of the last digit.

Example:

Key in 254.46
by pressing the keys
2 5 4 . 4 6

Display

254.46

The resultant number 254.46 appears in the display.

NEGATIVE NUMBERS

To key in a negative number, press the keys for the number, then press the \boxed{CHS} (change sign) key. The number, preceded by a minus (-) sign, will appear in the display. For example, to change the sign of the number now in the display:

Press

\boxed{CHS}

Display

-254.46



You can change the sign of either a negative or a positive nonzero number in the display. For example, to change the sign of the -254.46 now in the display back to positive:

Press

CHS

CLR X

Display

254.46

0.00

VECTOR FORMAT

To key in a number in "vector format," first press the keys for the distance. Next, press the \angle key and then the keys for the heading.

Example:

Key in 55.7 (miles) at 270°
by pressing the keys

5 5 . 7 \angle 2 7 0

Display

55.7 \angle 270.

IMPORTANT: This vector format will be used extensively in the navigation functions to show two separate quantities at the same time — such as distance and heading.

TIME FORMAT

To key in a number in time format — that is, in hours, minutes and seconds, first press the keys for the hours. Then press the decimal point key to separate the hours and the minutes. Next, press the keys for the minutes followed by the decimal point key to separate the minutes and the seconds. Finally, press the keys for the seconds.

Example:

Key in 21hrs 48min 30sec.
by pressing the keys

2 1 . 4 8 . 3 0

Display

21.48.30

NOTE: It is the entry of the second decimal point that distinguishes the time format from an ordinary number. Therefore, an acceptable time format is: 21.48.

One-Number Functions

In spite of the many functions available on the Computer keyboard, you will find the Computer functions simple to operate by using the following simple rule: When you press a function key, the Computer immediately executes the selected function.



To use any one-number function key, use the following procedure:

1. Key in the number.
2. Press the function key (or press the proper prefix key, then the function key).

For example, to convert the distance in miles into kilometers, key in the number, then press . To convert 15 miles into kilometers, key in 15 and press .

Press	Display
15	15.
	24.14

You can also convert the displayed number back to miles by pressing .

ERROR DISPLAY

If you key in an invalid operation, the word "Error" will appear in the display.

For example, if you try to use the temperature conversion on a number in vector format, the Computer will recognize it as an invalid operation:

Press	Display
127 42	127. 42.
	Error

Pressing any key clears the error and the operation is not executed. The number that was in the display before the error-causing function is returned to the display so you can see it.

Press	Display
	127.00 42.00

Operations that cause an error condition are listed on Page 92 of this Manual.

LOW BATTERY DISPLAY

When you operate the Computer from battery power, each of the 14 decimal points will glow to warn you when the battery is close to discharge. Even when all decimal points are turned on, the true decimal point position is known because an entire digit position is allocated to it.

Example:

True decimal point position.

You must then connect one of the chargers to the Computer and operate from AC power or 12VDC, depending on which charger you plan to use.

FLIGHT FUNCTIONS

Introduction

Your Aircraft Navigation Computer will execute all necessary computations for preflight, in-flight, and navigational needs. In this section of the Manual, you will first become familiar with the Computer's flight keys. Each key is listed with a brief description of its function. NOTE: More detailed description of each key will be given in the "Typical Flight Plan." Next, we will make up a flight plan by first entering typical preflight data into the Computer. Then we will simulate an actual flight and use the information available in the Computer during the flight. We assume that the aircraft is equipped with a VOR receiver, and you are going to fly the last leg of our simulated flight navigating by VOR.

Flight Key Functions

Refer to the keyboard of your Computer to help you visualize the use of the following flight keys.

PREFLIGHT KEYS

CAS	—	Keys in calibrated air speed.
°C	—	Keys in temperature in °C.
PALT	—	Keys in pressure altitude in feet.
VAR	—	Keys in magnetic compass variation.
FUEL	—	Keys in fuel supply on board.
RATE	—	Keys in fuel consumption rate.
WIND	—	Keys in reported wind vector (speed \angle direction).
LEG_n	—	Keys in up to nine legs in vector format (distance \angle heading).

IN-FLIGHT KEYS

ST.LEG_n	—	Commands the Computer to start the desired (n-th) flight leg. True airspeed and magnetic heading of the flight leg, in vector format, is displayed.
LEG_n	—	Recalls the n-th leg vector entered in preflight.
POSΔ	—	When pressed, after keying in distance and magnetic heading flown from the last checkpoint, the Computer displays the updated wind vector.



TAS MH	—	Calculates true airspeed (from preflight data) and magnetic heading (from solving wind triangle). Shown in vector format.
FUEL	—	When pressed, shows current fuel supply on board. If you are in a flight leg, display is gradually decreasing.
GS TC	—	Calculates ground speed from wind triangle and displays it with current flight leg course in vector format.
ETA Δ	—	Calculates estimated time of arrival at the next checkpoint based on computed ground speed.
ETA	—	Calculates estimated time of arrival at the final destination. NOTE: This is based on the sum of the estimated time for each of the flight legs entered in the Computer.
WIND	—	Recalls current wind vector (speed and direction). If winds have not been updated, it would be equal to the entered preflight data.
O/T DES	—	Gives dynamic display of distance and time to the end of all flight legs.
O/T Δ	—	Gives dynamic display of distance and time to the next checkpoint.
Δ	—	"Tells" the Computer that you have arrived at the checkpoint (end of that flight leg). This commands the Computer to start the next flight leg. The wind vector is now recomputed based on when you arrived at the checkpoint. If you were flying a heading that was different from the magnetic heading in the previous flight leg, the actual heading you were flying may be keyed in and included in the wind update. The Computer displays true airspeed and magnetic heading of the next flight leg in vector format.
LAST Δ	—	Reverts all data present in the Computer to what it was before the Δ key was pressed prematurely or by accident.

NAVIGATION KEYS

RAD 1	—	Keys in radial from VOR 1 (from VOR receiver reading).
RAD 2	—	Keys in radial from VOR 2 (from VOR receiver reading).
VR ₁₂	—	Keys in distance and angle from VOR 1 to VOR 2 in vector format (from charts).
VR ₁ Δ	—	Keys in distance and angle from VOR 1 to checkpoint in vector format (from charts).



- | | | |
|------------------|---|------------------------------------------------------------------------------------------------------------|
| VR _{1P} | — | Calculates distance from VOR 1 to plane. Displays distance and angle from VOR 1 to plane in vector format. |
| DST MH | — | Calculates new distance and magnetic heading, in vector format, to checkpoint. |

TIME FUNCTION KEYS

- | | | |
|--------|---|--------------------------------------------------------------------------------------------------------------------------------|
| SET | — | When pressed, with a time format number (two decimal points) in the display, sets the clock to that time and starts the clock. |
| CLK | — | Accesses the true time display. |
| S/S ET | — | Starts elapsed time. If the timer is already running, pressing this key stops the elapsed time. |
| ET | — | Displays the elapsed time. |
| CLR | — | Stops the elapsed time and clears it to zero. |

Typical Flight Plan

IMPORTANT: The following flight plan has been designed to increase your proficiency in the actual use of the navigational features of your Computer. It is extremely important that you go through this plan several times, using your Computer, to become totally familiar with its use **before** you start on an actual flight.

When you operate your Computer during the following simulated flight, some of the displayed numbers or answers you see may be different than those listed in this Manual. These particular answers are calculated based on time. Since time is "running" during the simulated flight, the time you use in each of these calculations may be different than the time used to arrive at each of the answers listed. Do not be concerned with these discrepancies.

The following preflight data will now be loaded into the Computer. These entries are similar to the data which would be logged for any good flight plan. **NOTE:** Before an actual flight, you may wish to enter your flight data at home, since the data may be kept in the Computer's standby mode for up to 10 hours with the internal batteries fully charged.

NOTE: The following entries are best estimates for in-flight conditions. However, during the flight, you may replace these entries with actual in-flight data.

- | | | |
|----------------------------------|---|------------|
| Calibrated Air Speed | — | 119 knots. |
| Temperature (at flight altitude) | — | 68°F. |
| Pressure Altitude | — | 3300 ft. |
| Magnetic Variation | — | 3° E. |
| Fuel tank capacity (usable) | — | 40 gal. |



Fuel consumption rate	— 8 gal/hr.
Wind	— 12 knots @ 210°.
Flight legs	
1. A to B	— 45 naut mi @ 83° true course.
2. B to C	— 33 naut mi @ 109° true course.
3. C to D	— 19-1/2 naut mi @ 134° true course.

NOTE: You may choose one of the various units for Calibrated Air Speed, Fuel tank capacity, Wind, etc. However, you must retain these units for the duration of the flight plan. Also make sure these units are related as indicated in the example below.

DISTANCE	SPEED	FUEL	RATE
Nautical miles	Knots	Gallons	Gallons/hour
Miles	Miles/hour	Liters	Liters/hour

LOADING PREFLIGHT DATA

To begin:

- () Make sure the NORMAL-STANDBY switch is in the NORMAL position.
- () Slide the OFF-ON switch to ON.

Next, the preflight data will be loaded into the Computer.

Calibrated Air Speed

Press	Display
119 <input type="button" value="F"/> <input type="button" value="CAS"/>	119.00

This value for CAS is stored for future calculations.

Temperature

Press	Display
68 <input type="button" value="F"/> <input type="button" value="°F"/> <input type="button" value="°C"/> <input type="button" value="°C"/>	20.00

The temperature, in °C, is stored for future calculations.

NOTE: You only need to press the indicated temperature conversion keys if the temperature is given in degrees Fahrenheit.



Pressure Altitude

Press		Display
3300	<input type="button" value="F"/> <input type="button" value="PALT"/>	<input type="text" value="3300.00"/>

NOTE: The data for Calibrated Air Speed, Temperature, and Pressure Altitude are used to compute True Air Speed.

Magnetic Variation

NOTE: Remember that "East is Least and West is Best," so for the 3° E variation, enter -3 in the Computer.

Press		Display
3	<input type="button" value="CHS"/> <input type="button" value="VAR"/>	<input type="text" value="-3.00"/>

Fuel Tank Capacity

Press		Display
40	<input type="button" value="F"/> <input type="button" value="FUEL"/>	<input type="text" value="40.00"/>

Fuel Consumption Rate

Press		Display
8	<input type="button" value="RATE"/>	<input type="text" value="8.00"/>

Wind

NOTE: Wind has both magnitude and direction so it is entered in vector format.

Press		Display
12	<input type="button" value="∠"/> 210 <input type="button" value="F"/> <input type="button" value="WIND"/>	<input type="text" value="12.00 ∠ 210.0"/>

Flight Legs

NOTE: Up to nine flight legs may be stored in the Computer. However, in the example, only three will be stored.

All the flight legs are also entered in vector format since they also have both magnitude and direction.

Press		Display
45	<input type="button" value="∠"/> 83 <input type="button" value="LEG,"/> 1	<input type="text" value="45.00 ∠ 83.00"/>
33	<input type="button" value="∠"/> 109 <input type="button" value="LEG,"/> 2	<input type="text" value="33.00 ∠ 109.0"/>
19.5	<input type="button" value="∠"/> 134 <input type="button" value="LEG,"/> 3	<input type="text" value="19.50 ∠ 134.0"/>

Pressing the "1" key, for example, after informs the computer that you are entering flight leg 1.



RECALLING PREFLIGHT DATA

At this time, all the preflight information has been loaded into the Computer. This information may now be "recalled" to check for accuracy. This is done by pressing the **F** **RCL** keys followed by the key for the function you want to recall.

For example, to "recall" the temperature, merely:

Press	Display
F RCL °C	20.00

This is the temperature in °C.

To convert this back to your original entry (in °F), simply:

Press	Display
F⁻¹ °C → °F	68.00

This is the temperature you entered (in °F). However, the temperature in °C remains in the Computer for subsequent calculations.

Now recall the wind entry. Note that it is necessary to press the **F** key two times since both the recall and wind modes are "upper Case" functions.

Press	Display
F RCL F WIND	12.00 \angle 210.0

You may recall any of the flight legs by pressing the **F** **RCL** **LEG_n** keys followed by the number key for the desired flight leg.

For example, to recall flight leg 2, merely:

Press	Display
F RCL LEG_n 2	33.00 \angle 109.0

FLIGHT PLAN DATA

After the Preflight data are properly stored in the Computer, you may calculate the information you wish to record in your flight plan prior to the start of the flight. Use the In-flight **LEG_n** key to "bring" the Computer into the desired leg. For example, if you wish to calculate true air speed and magnetic heading for flight leg 1, simply:

Press	Display
LEG_n 1	45.00 \angle 83.00

The display shows the Preflight entry for distance and true course for flight leg 1. Now, the Computer is ready to calculate the data for leg 1. To see true air speed and magnetic heading for leg 1 displayed, simply:

Press	Display
TAS MH	127.19 / 84.32

Notice that immediately after you pressed the TAS MH key, the Computer showed the following notation in the display: L1. This is displayed for a short time while the answer to true air speed and magnetic heading is being computed. L1 means the Computer is calculating the information for flight leg 1.

To calculate ground speed and true course for this flight leg, just:

Press	Display
GS TC	134.05 / 83.00

Notice that the computed ground speed is greater than the true air speed due to the tailwind component of the wind. Also, the true course is the same as you keyed in for flight leg 1. See Pictorial 4-1.



PICTORIAL 4-1

Then, to calculate distance and time to checkpoint for the same flight leg, merely:

Press	Display
D/TΔ	45.0 0.20.08

It is 45.0 miles and 20 minutes, 8 seconds to checkpoint B.

To compute true air speed and magnetic heading for flight leg 2, just:

Press	Display
LEG, 2	33.00 / 109.0
TAS MH	127.19 / 111.3

Then, to calculate ground speed and true course for leg 2, simply:

Press	Display
GS TC	128.93 / 109.0



Distance and time to checkpoint for this flight is calculated when you:

Press	Display
<input type="button" value="D/TΔ"/>	<input type="text" value="78.0 0.35.29"/>

The total distance and time from checkpoint A to checkpoint C is displayed.

Notice that before the answer is displayed, the Computer display shows . This indicates that the distance and time displayed is calculated to the end of flight leg 2. Also notice the "2" changes to "1" during the computation; the Computer must also calculate the data for flight leg 1.

Finally, calculate true air speed and magnetic heading for flight leg 3. To do that, merely:

Press	Display
<input type="button" value="LEG."/> 3	<input type="text" value="19.50 ∠134.0"/>
<input type="button" value="TAS MH"/>	<input type="text" value="127.19 ∠136.3"/>

You calculate ground speed and true course for leg 3 when you:

Press	Display
<input type="button" value="GS TC"/>	<input type="text" value="123.75 ∠134.0"/>

Distance and time to checkpoint for flight leg 3 is computed when you:

Press	Display
<input type="button" value="D/TΔ"/>	<input type="text" value="97.5 0.44.57"/>

The display shows the total distance and flight time from the starting point to the end of the selected flight leg.

Since the last leg (leg 3) is now selected, pressing the key or the key gives the same answer.

STANDBY MODE

At this time, with the preflight data stored in the Computer, you may want to switch to the standby mode as follows:

IMPORTANT: Make sure you leave the OFF-ON switch in the ON position.

() Slide the NORMAL-STANDBY switch to STANDBY.

In the standby mode, all the data stored in the Computer is saved. However, it is not possible to perform any calculations in this mode. Also, the display is not lit. In this mode, the low battery drain allows you time to travel to the airport, if necessary. Whenever you are ready to fly, switch back to the normal mode as follows:

() Slide the NORMAL-STANDBY switch to NORMAL.



The display should first indicate OC-1401. Then the displayed information will move from left to right, and the digits present in the display before you pushed the NORMAL-STANDBY switch to STANDBY will again appear in the display.

CLOCK FUNCTIONS

True Time Clock

Before you start the aircraft engine, you must set the Computer clock. You do this by keying in the current time; then you press the F SET keys. Assume you have arrived at the airport and are ready to start your simulated flight. (NOTE: The clock does not run in the standby mode.) Also, assume the local time is 2:00 PM, or 14:00 using 24-hour format. Remember that the time format requires two decimal points:

Press	Display
14.00.	14.00.

This is the display until you press the F SET keys.

F SET	14.00.01
-------------------------------------------------------------------------------------------------------------------------------------	---------------------------------------------------------------------------

This is the display just after you pressed F and SET. The display now continues to keep track of true time.

If you wish to "remember" the actual time a specific event happened during your flight, you may store this time in one of the nine addressable storage registers available in your Computer. For information on how to store and recall this and other dynamic displays, refer to the section titled "Storing and Recalling Numbers" on Page 90 of this Manual. NOTE: When you recall this time, the exact time including the number of seconds will be displayed.

Elapsed Time Clock

The elapsed time (ET) clock is separate from the true time clock. The ET clock is used to monitor fuel usage and flight time, so you should start and stop this clock and the aircraft engine at the same time.

Assume that you now are ready to start your engine, so:

Press	Display
S/S ET	00.00.01

This is the display just after you pressed the S/S ET key. The display now continues to increment elapsed time.

NOTE: You start and stop the ET clock by subsequent S/S ET keystrokes.



You may see either true time or elapsed time displayed any time you wish. For example, to see true time 5 min 30 sec after you set the clock, just:

Press	Display
<input type="button" value="F-1"/> <input type="button" value="CLK"/>	<input type="text" value="14.05.30"/>

To see elapsed time 6 min, 45 sec after you pressed , simply:

Press	Display
<input type="button" value="F-1"/> <input type="button" value="ET"/>	<input type="text" value="0.06.45"/>

As explained under the previous heading, you may store this information in one of the nine addressable storage registers in your Computer.

To clear elapsed time, merely press the keys.

IN-FLIGHT COMPUTATIONS

NOTE: Make sure the preflight data are stored in your Computer whenever you go through this section of the Manual. Remember that this information is lost when you turn the Computer off.

You are now ready to take off on the simulated flight. You may find it convenient to locate the start of flight leg 1 a few miles from the airport. This will allow you time to reach the desired altitude and ground speed. NOTE: In this example, you will be allowed five minutes. That is, after five minutes have elapsed, as shown by the ET display, start leg 1 as described in the following paragraph.

Air Speed and Magnetic Heading

When you fly over the starting point (start of flight leg 1), simply:

Press	Display
<input type="button" value="F"/> <input type="button" value="ST.LEG."/> 1	<input type="text" value="127.19 /84.32"/>

True air speed and magnetic heading is displayed.

Notice that immediately after you pressed the 1 keys, the Computer showed the following notation in the display: This is displayed for a short time while the answer to true air speed and magnetic heading is being computed. FL1 means that you are in flight leg 1.

You should fly your aircraft by the displayed magnetic heading. This heading was computed from the desired true course of flight leg 1, the wind, and the magnetic variation. NOTE: You can also get the same information displayed by pressing the key.

Ground Speed

Various data, which you may find helpful during the flight, are now available in your Computer. For example, if you like to know what your ground speed is, merely:

Press

GS TC

Display

134.05 / 83.00

It is also possible to determine ground speed and true course for a future flight leg while you are still flying leg 1. Use the **In-flight** LEG_n key to "bring" the Computer into the desired leg. For example, if you like to know what the ground speed and true course will be for flight leg 2, simply:

Press

LEG_n 2

Display

33.00 / 109.0

The display shows the Preflight entry for distance and true course for flight leg 2. Now, the Computer is ready to calculate the data for leg 2. To see ground speed and true course for leg 2 displayed, merely:

Press

GS TC

Display

128.93 / 109.0

Notice that before the answer is displayed, the Computer display indicates FL 1 L2. This means that you are still in flight leg 1, but the answer displayed is for leg 2.

To return the Computer to the calculation mode for flight leg 1, just:

Press

LEG_n 1

Display

45.00 / 83.00

Fuel Remaining

Assume that after about 10 minutes of flying time, you decide to check how much fuel is left. In this case, make sure you press the **In-flight** fuel function key, so:

Press

F

FUEL

Display

38.67

Approximate amount of fuel remaining.

Notice as you fly, the amount of fuel remaining is constantly changing as indicated by the display. This is called a **dynamic display**.



If you wish to "remember" the amount of fuel remaining on board at the end of a specific flight leg, you may store this number in one of the addressable storage registers in your Computer. For information on how to store and recall this data, refer to "Storing and Recalling Numbers" on Page 90 of this Manual.

Flashing "F" Fuel Indicator

At the moment the fuel on board reaches zero, as calculated by the Computer, a flashing "F" will appear on the left side of the Computer display. The flashing F appears regardless of what data happens to be in the display at the time. When that occurs in an actual flight, you start using fuel from your reserve capacity; therefore it's time to think about refueling your plane.

To demonstrate this feature, temporarily key in a different number for the initial fuel supply on board. Let's say that instead of 40, you key in .05 for fuel as part of the preflight data. To load the temporary data for fuel into the Computer, just:

Press	Display
.05 F FUEL	0.05

Notice as you watch the number in the display get smaller, it changes from fixed point to scientific notation* display when the value drops below 0.01. When the number reaches 0.00, the flashing "F" appears in the display. The number continues to be displayed in scientific notation as it goes negative. At -0.01 it again switches to a fixed point display and continues to go more negative. Also notice at this time the "-" sign is the lower bar of the flashing F.

To key in the original value as preflight data, simply:

Press	Display
40 F FUEL	40.00

Notice that the flashing F has now disappeared.

IMPORTANT: Any of the Preflight entries may be altered any time you wish to do so. For example, if you intend to change your altitude, enter the new altitude into your Computer. The Computer will then recalculate the In-flight data based on the revised entry.

Distance and Time to Checkpoint

How far are you now from your first checkpoint if you have been flying 11-1/2 minutes since you started on flight leg 1?

Press	Display
O/T Δ	19.40 0.08.40
	<div style="display: flex; justify-content: space-around; width: 100%;"> ↙ Distance ↘ Time </div>

* Scientific notation will be explained on Page 65.

The remaining distance to the first checkpoint is now shown on the left side of the display, while the remaining time appears on the right side.

This display is very convenient. It may help you find the next checkpoint; the display for both distance and time should be very close to zero when you fly over the checkpoint. NOTE: A negative number indicated for distance and an incrementing time display could mean that you are arriving late or have already passed the checkpoint. However, other factors could also cause this to happen. But in general, the D/T Δ function provides quite accurate results.

The Computer can also calculate and display distance and time for future checkpoints while you are still flying leg 1. Use the In-flight LEG, key to bring the Computer into the desired leg. For example, if you wish to know what the distance and time are for checkpoint 2, just:

Press	Display
LEG, 2	33.00 2109.0

The display now shows the Preflight entry for distance and course for flight leg 2. Now, the Computer is ready to calculate the data for leg 2. To see distance and time for checkpoint 2 displayed, merely:

Press	Display
D/T Δ	50.5 0.23.11

Notice that before the answer is displayed, the Computer display shows FL1 L2. This indicates that the distance and time displayed is calculated to the end of flight leg 2. Also notice the "2" changes to a "1" during the computation; the Computer must also calculate the data for flight leg 1.

Now, return the Computer to the leg 1 calculation mode, as follows:

Press	Display
LEG, 1	45.00 283.00

If you wish to "remember" the distance and time to checkpoint for one or more of your flight legs, you may store this data in the Computer's addressable storage registers. Refer to the section titled "Storing and Recalling Numbers," on Page 90 of this Manual for information on how to store and recall similar displayed data. NOTE: When you recall this data, only the hours and minutes of the time portion of the data will be displayed. The number of seconds originally stored will be replaced by "0."

Distance and Time to Destination

The distance and time to destination (D/T DES) function is similar to the distance and time to checkpoint (D/T Δ) function, except it provides distance and time for all flight legs. With as many as nine possible legs in a flight, the calculation of the D/T DES function can become quite time consuming for the Computer, since it must calculate wind triangles for each flight leg.



To find the distance and time to destination for the simulated flight 15 minutes after you started flight leg 1, simply:

Press	Display
<input type="button" value="F"/> <input type="button" value="O/T DES"/>	<input type="text" value="64.1 0.29.58"/>

The remaining distance to the destination is now shown on the left side of the display, while the remaining time appears on the right side.

Estimated Time of Arrival

The two ETA functions are also quite useful. ETA_{Δ} gives the estimated time of arrival at the end of the current leg you are flying. Assuming that you started flight leg 1 at 14:10, you get the estimated time of arrival at the end of leg 1 if you:

Press	Display
<input type="button" value="F-1"/> <input type="button" value="ETA <math>\Delta</math>"/>	<input type="text" value="14.30.10"/>

If you want to know the estimated time of arrival at the final destination (the end of flight leg 3), simply:

Press	Display
<input type="button" value="F"/> <input type="button" value="ETA"/>	<input type="text" value="14.55.00"/>

The Computer can also calculate and display estimated time of arrival at the end of any flight leg while you are still in flight leg 1. Use the In-flight LEG_n key to "bring" the Computer into the desired leg. For instance, if you want to know what the estimated time of arrival at checkpoint 2 is, simply:

Press	Display
<input type="button" value="LEG<sub>n</sub>"/> 2	<input type="text" value="33.00 <math>\angle</math> 109.0"/>

The display now shows the Preflight entry for distance and true course for flight leg 2. At this time, the Computer is ready to calculate the data for leg 2. To see estimated time of arrival at checkpoint 2 displayed, just:

Press	Display
<input type="button" value="F-1"/> <input type="button" value="ETA <math>\Delta</math>"/>	<input type="text" value="14.45.33"/>

Notice that before the answer is displayed, the Computer display shows . This indicates that you are in flight leg 1 and the estimated time of arrival is calculated for checkpoint 2. Also notice the "2" changes to a "1" during the computation; the Computer must also calculate the data for flight leg 1.



Now, return the Computer to the leg 1 calculation mode, as follows:

Press	Display
LEG_n 1	45.00 / 83.00

Start of n-th Flight Leg

Now assume that you have about two minutes left to fly before you are at the end of the first flight leg. To see this, merely:

Press	Display
D/T Δ	4.50 0.02.00

Wait until the display for distance and time decrement to zero; then

Press	Display
F ST.LEG_n 2	127.19 / 111.3

NOTE: It is important to understand that the ST.LEG_n command always starts the n-th leg regardless of what leg you have been previously flying. For example, if you like to refly leg 1 for practice, you may press the **ST.LEG_n** 1 keys. Keep in mind, however, that "time, elapsed time, and fuel" will continue to "run".

NOTE: You have now "informed" the Computer that you have arrived at your first checkpoint. Also, you wish to start a new flight leg, in this case, flight leg 2. The Computer will now display the true air speed and magnetic heading that you need to fly leg 2. This new magnetic heading was arrived at by computing the new wind triangle based on the given desired course and the wind that you programmed as preflight data. The magnetic heading that the Computer displays is similar but not quite equal to the true course programmed for flight leg 2. This is because the wind is accounted for in the magnetic heading by solving the wind triangle.

As in flight leg 1 you may now access any of the helpful functions available; such as fuel, distance and time to checkpoint, distance and time to destination, and estimated time of arrival.

For example, if you want to know what your ground speed is, simply:

Press	Display
GS TC	128.93 / 109.0

Checkpoint and Wind Update

Assume that you are close to the end of flight leg 2. Press the **D/T Δ** key so you can monitor distance and time remaining of this flight leg. When these numbers reach zero, press the **Δ** (checkpoint) key. This key is another way to enter the next flight leg. Unlike the **ST.LEG_n** key, where n is 3 in this



case, the key updates the wind. The Computer does this by determining how far ahead or behind schedule you are at the end of a flight leg. It then updates the wind data accordingly. You may see the new wind vector displayed by pressing the In-flight key.

Let's say that you arrive at the checkpoint at the end of flight leg 2 with exactly one minute remaining in the time portion of the display. At that time, simply:

Press	Display
<input type="button" value="Δ"/>	<input type="text" value="127.19 / 138.0"/>

The Computer now displays the true air speed and magnetic heading that you need to fly leg 3. This new magnetic heading was arrived at by computing the new wind triangle based on the given desired course and the updated wind.

NOTE: If you press the key much too soon, the Computer will calculate a tailwind of unreasonable magnitude. If this happens, the Computer will display "Error." Then, by pressing any of the keys, the Computer returns to the same leg you were flying. (The Computer has ignored your checkpoint (Δ) command).

To see the updated In-flight wind vector, just:

Press	Display
<input type="button" value="WIND"/>	<input type="text" value="16.39 / 243.0"/>

NOTE: The updated wind vector also replaces the "wind" previously entered into the Computer as part of the preflight data.

In an actual flight, you could possibly mistake a physical feature along your flight path for your checkpoint, and therefore, press the key too soon. As soon as you have discovered this mistake, you must "inform" the Computer of this. This is the purpose of the key function. Pressing the keys, returns the Computer to the previous flight leg and restores the wind vector to its original value. The Computer will then make its calculations as if the key was never pressed.

Therefore, if you press the Δ key too soon, simply:

Press	
<input type="button" value="F"/> <input type="button" value="LASTΔ"/>	NOTE: The display remains unchanged.

By making this mistake, you may have spent more time reaching the actual checkpoint than would have normally been required. The computer will calculate an incorrect wind vector if you press the key when you arrive at the actual checkpoint. Therefore, it would be wise to press the n* keys when you start your next flight leg. In fact, you should not use the key when you have made any deviation from the planned flight leg.

*n is the next leg you intend to fly.

Navigation

The navigation functions of your Computer are designed to be used with two VOR stations. This is a "RNAV" type navigation function. To prepare for navigation by the VOR's, you must load two preflight entries into your Computer. These two entries are the vectors VR_{12} and $VR_{1\Delta}$. You should measure these vectors on your aeronautical chart either before you start flying or some time before you need this data during your flight.

VR_{12} is the vector between the two VOR stations you will be using. You can measure this vector from the aeronautical chart by placing a straight edge between the two VOR stations and reading the radial to the second VOR on the VOR 1 scale. NOTE: Since the scales surrounding the VOR stations on an aeronautical chart are magnetic headings, VR_{12} is a magnetic vector. This is automatically accounted for in the Computer.

You should also measure $VR_{1\Delta}$ from the aeronautical chart. This is the magnetic vector from VOR 1 to the destination which is the end of that flight leg.

Carefully measure both of these vectors, as the accuracy in measurement affects the accuracy of the navigation functions. Key in both vectors in vector format: enter the distance first and then the magnetic angle.

At any time during a navigation flight leg, you may enter a radial from each of the two VOR stations into the Computer by using the **RAD 1** and **RAD 2** keys. Using the keyed-in data, the Computer will calculate the distance and magnetic heading you have to fly to reach the desired destination.

Pictorial 4-2 illustrates the course you should follow to get from checkpoint 2 to your final destination. The locations of the two VOR stations you will be navigating by to get there are also shown.

NOTE: Make sure the preflight data are stored in your Computer whenever you go through this section of the Manual. Remember that this information is lost when you turn the Computer off. At this time, it is assumed that the wind vector, which was updated at the end of flight leg 2, is still stored in your Computer. This wind vector is given on Page 47 of this Manual.

DISTANCE AND ANGLE FROM VOR 1 TO VOR 2

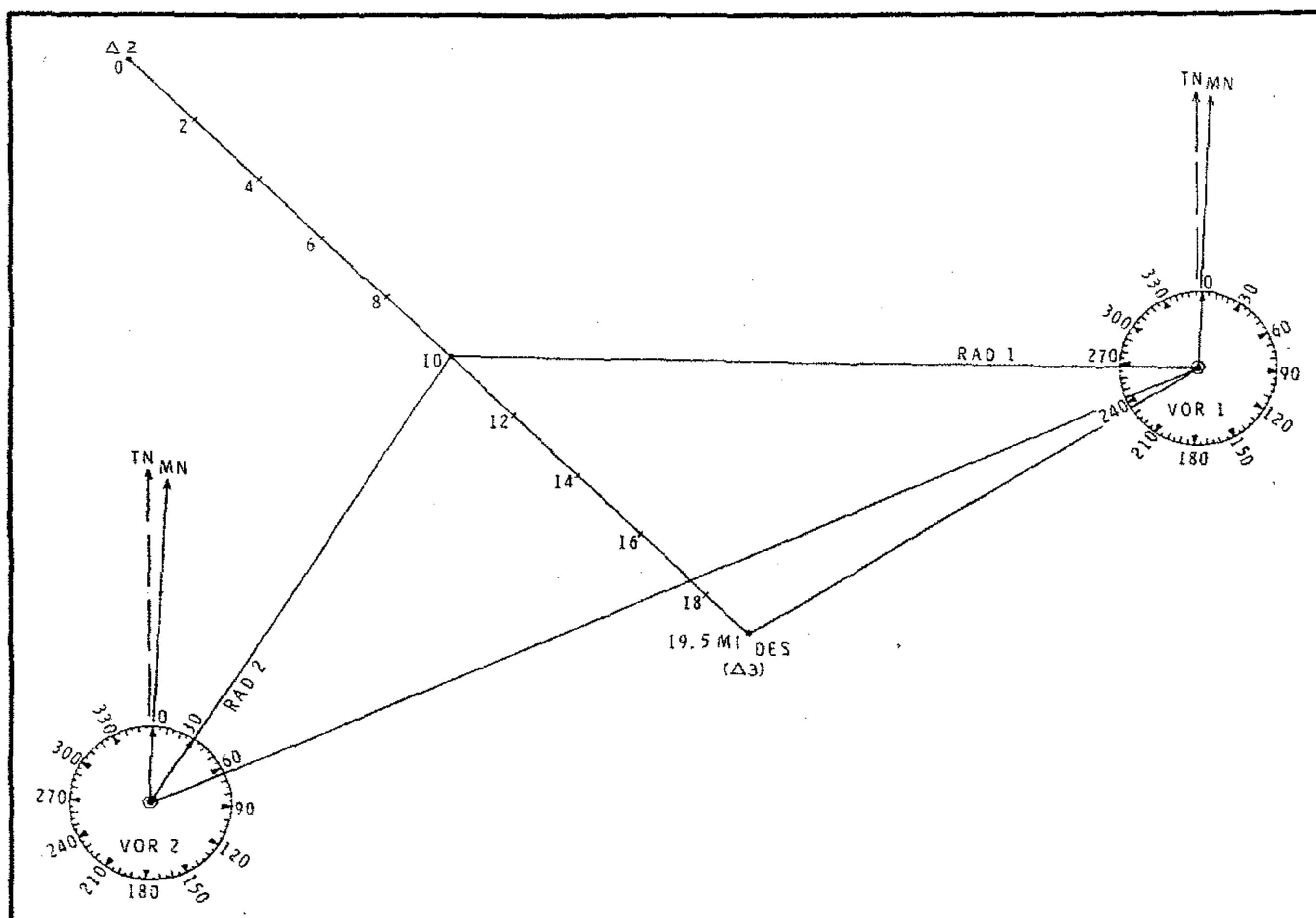
To enter the magnetic vector VR_{12} , as taken from the chart, simply:

Press		Display
26	∠ 244 F VR_{12}	26.00 ∠ 244.0

DISTANCE AND ANGLE FROM VOR 1 TO CHECKPOINT

To enter the magnetic vector $VR_{1\Delta}$, as taken from the chart, merely:

Press		Display
12	∠ 236 $VR_{1\Delta}$	12.00 ∠ 236.0



PICTORIAL 4-2

RADIALS FOR VOR 1 AND VOR 2

NOTE: You may read the radials from the two VOR stations on your receiver at any time while you are flying towards your destination.

Example 1: You have flown about half the distance of leg 3. Then you read the following radials:

From VOR 1: RAD 1 is 268° and from VOR 2: RAD 2 is 30°.

To enter these radials into the Computer, just:

Press		Display
268	<input type="button" value="F"/> <input type="button" value="RAD 1"/>	<input type="text" value="268.00"/>
30	<input type="button" value="RAD 2"/>	<input type="text" value="30.00"/>



DISTANCE AND MAGNETIC HEADING

At this time, the Computer has all the information it needs to compute the new distance and magnetic heading you must fly to reach your desired destination. Therefore, simply:

Press	Display
<input type="button" value="DST MH"/>	<input type="text" value="9.43 / 137.3"/>

NOTE: As you can tell from the numbers in the display, you were right on course when you read the radials from the two VOR stations.

Example 2: Assume that you have flown about half the distance between checkpoint 2 and your destination. Then you read the following radials:

From VOR 1: RAD 1 is 270° and from VOR 2: RAD 2 is 35°.

To enter these radials into the Computer, simply:

	Press	Display
270	<input type="button" value="F"/> <input type="button" value="RAD1"/>	<input type="text" value="270.00"/>
35	<input type="button" value="RAD2"/>	<input type="text" value="35.00"/>

To compute the new distance and magnetic heading you must fly to reach your destination, merely:

Press	Display
<input type="button" value="DST MH"/>	<input type="text" value="8.64 / 148.2"/>

NOTE: For some reason, you have now drifted off course as indicated by the new magnetic heading in the display.

DISTANCE AND ANGLE FROM VOR 1 TO PLANE

You can determine where you are located on the aeronautical chart at any time you wish by entering the two radials from VOR 1 and VOR 2 to the plane. To find the vector from VOR 1 to the plane when RAD 1 is 270° and RAD 2 is 35°, simply:

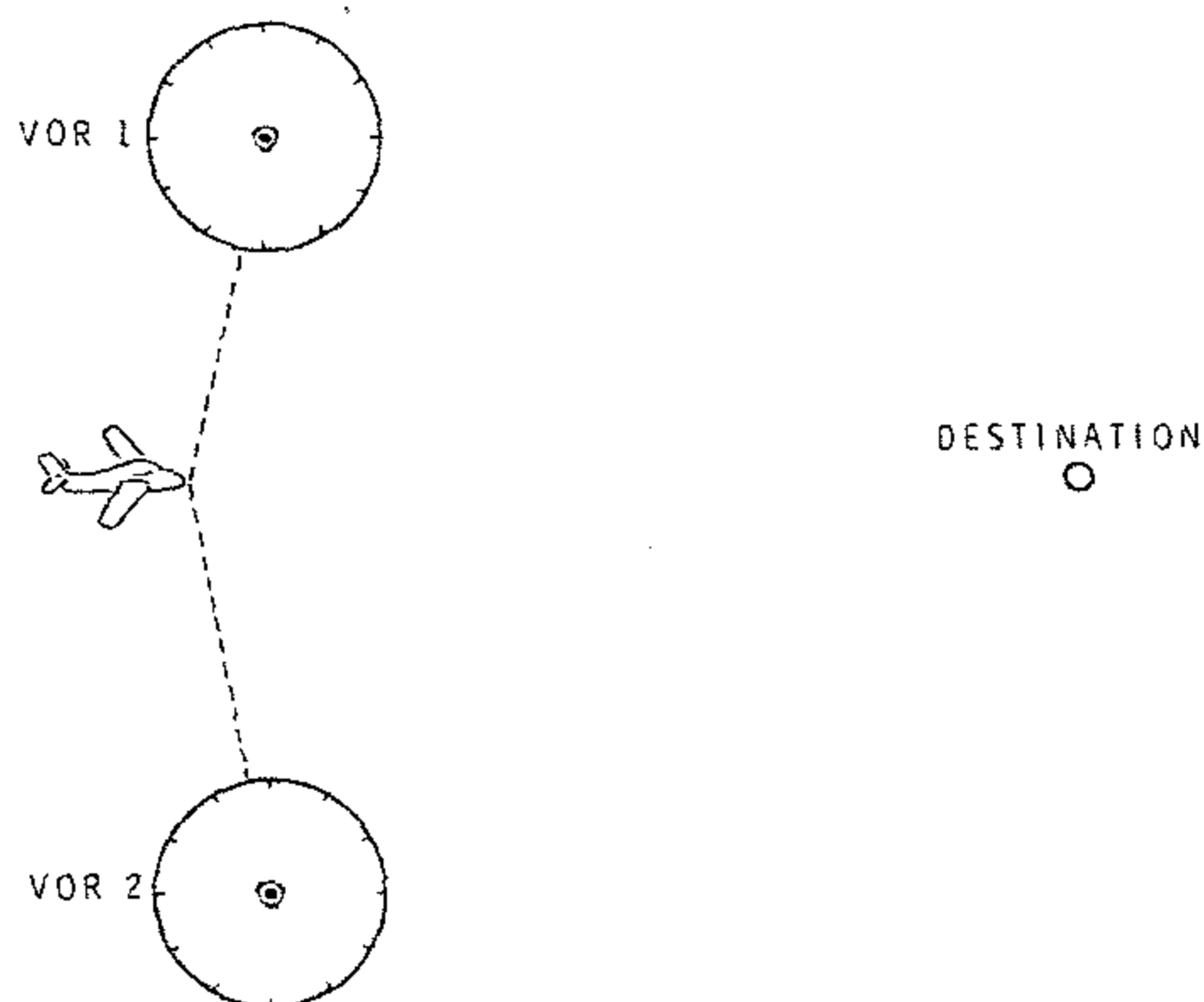
Press	Display
<input type="button" value="F"/> <input type="button" value="VR<sub>1P</sub>"/>	<input type="text" value="15.39 / 270.0"/>



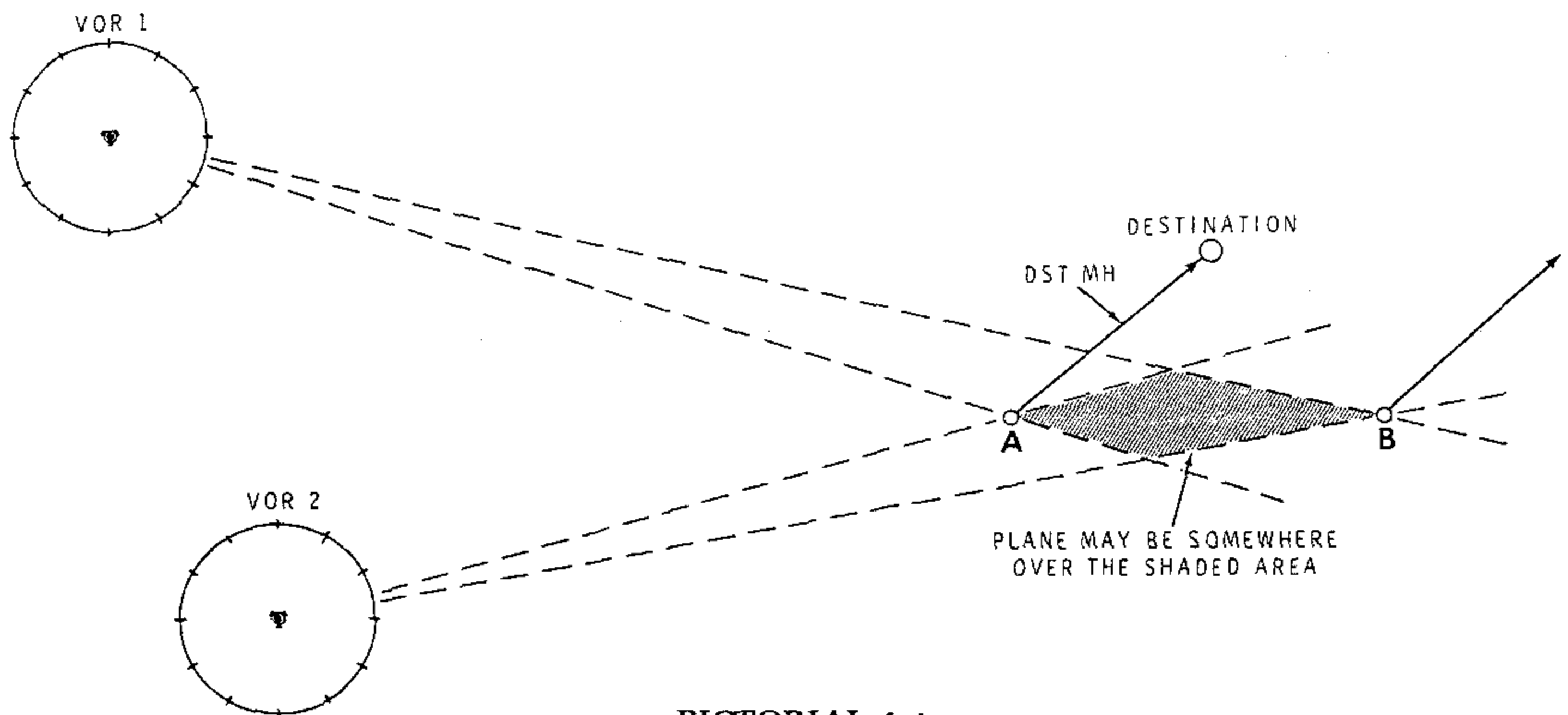
To find the present position of your plane, just use the straight edge to measure the distance and angle, as given in the display, from VOR 1.

When you navigate by VOR, it is wise to know where you are located on the aeronautical chart in order to visualize the questions "asked" of the Computer. For example, assume you attempt navigation by VOR in the situation shown in Pictorial 4-3 below.

In this situation, the Computer is very sensitive to small errors in the input radials. An error of one or two degrees can easily make a drastic difference in the Computer's displayed answer. Incidentally, if you happen to be on the line exactly between the two VOR stations, it is impossible for the Computer to determine where you are! To guard against this, visualize the data you enter into the Computer. Also, use common sense to avoid such situations.



PICTORIAL 4-3



PICTORIAL 4-4

Another possible way of producing erroneous answers is by attempting to use the VOR navigation functions when you are too close to your destination. In this situation, small errors always possible in the input radials can mean that the heading computed for your destination could be grossly in error. See Pictorial 4-4. For example, if you enter radials RAD 1 and RAD 2 when you are flying over point A, the Computer will calculate and display the correct distance and magnetic heading you have to fly to reach your destination. However, if you enter the same radials while you are flying over point B, the Computer will display the same answer as it did before. The result, however, is that you will be flying a course parallel to the correct one and away from your destination. Therefore, do not try to compute a new magnetic heading when you find yourself in a situation like this.

NOTE: Keep in mind that the accuracy of the data provided by the Computer is limited by the accuracy of the VOR system and the aircraft's receiver and bearing system. These inaccuracies can amount to several degrees, which under certain conditions, can alter your position significantly.

IN-FLIGHT VARIATIONS

Checkpoint Key with Altered Heading

When you previously flew flight leg 2, you used the checkpoint (Δ) key to indicate the end of that flight leg. During this leg, you flew a heading according to the Computer's true air speed and magnetic heading (TAS MH) display. However, it is common to change the magnetic heading if there is a difference between the preflight wind and the actual wind (for example, during a flight directly to a VOR station).



Assume that you are again flying leg 2, but this time, you fly directly toward a VOR station and correct your heading if you drift off course. By watching the indicator of the VOR receiver, you know that you are consistently flying the proper course. However, in order to do this, you may not be flying the heading that is shown in the Computer's true airspeed and magnetic heading display. When this is the case, you must "inform" the Computer what heading you have been flying before you press the checkpoint key. To do this, merely key in the heading you have been flying before you press the checkpoint key. The Computer will then update the wind vector based on the heading that you have been flying. NOTE: If you do not inform the Computer what heading you have been flying, the Computer will update the wind vector based on an incorrect heading. That is, it assumes you flew the heading it computed for you.

Just before you start flight leg 2, assume you have a wind vector of 15 mph @ 242°. To enter this data into the Computer, simply:

Press			Display
15	<input type="text" value="∠"/>	242 <input type="text" value="F"/> <input type="text" value="WIND"/>	<input type="text" value="15.00 ∠ 242.0"/>

When you are ready to start flight leg 2, merely:

Press			Display
<input type="text" value="F"/>	<input type="text" value="ST.LEG."/>	2	<input type="text" value="127.19 ∠ 110.9"/>

NOTE: This is the computed true airspeed and magnetic heading required to reach the VOR station at checkpoint 2.

Instead of flying the displayed heading, assume you must fly a heading of 108° in order to stay on the radial from the VOR station. Apparently the wind is different from what you assumed just before you started flight leg 2.

At this time, press the key so you can monitor the distance and time remaining in this flight leg. When the time portion reaches exactly two minutes, the display shows:

<input type="text" value="4.63 0.02.00"/>

Let's say that you arrive at the checkpoint at the end of flight leg 2 with about one minute remaining in the time portion of the D/TΔ display. You must enter the actual heading you have been flying into the Computer as you reach the end of flight leg 2. To do this, just:

Press		Display
<input type="text" value="∠"/>	<input type="text" value="108"/>	<input type="text" value="∠ 108"/>
<input type="text" value="Δ"/>		<input type="text" value="127.19 ∠ 136.7"/>



The Computer now displays the true air speed and magnetic heading that you need to fly leg 3.

If you want to know what the updated in-flight wind vector is, merely:

Press

WIND

Display

20.87 / 276.7

Position Checkpoint Key

Position checkpoint (POS Δ) is a function that is similar to the checkpoint (Δ) function, except you may use it any time during a flight leg. Again, using flight leg 2 as an example, suppose you are flying toward the VOR station and part way through the flight leg you wish to update the wind vector. To do this, you must know your current position along this flight leg. You may determine this by noting a particular physical feature along your flight path. You must then determine how far along you are on that leg by measuring the distance from your previous checkpoint on the chart.

By flying directly toward the VOR station, you may maintain a constant radial with respect to that station. Therefore, you have a constant heading that you have been maintaining in order to hold that radial.

At this time, you have the information that the Computer needs to determine your position; that is, the distance from your previous checkpoint. This assumes that you are on course. Then, by providing your Computer with the distance from your last checkpoint, the Computer "knows" your position. Also, by entering the heading you have been flying, the Computer will combine this information with its calculation of what your present location should have been (based on the old winds). Then, the Computer will update the wind vector.

Then press the position checkpoint key. The Computer will then update and display the wind vector based on this information. NOTE: You should use this function only after you have flown a considerable distance during the flight leg. If you enter the data into the Computer after too short a distance, inaccuracies may result.

Just before you start flight leg 2, let's say you have a wind vector of 15 mph @ 242°. To enter this data into the Computer, simply:

Press

15 / 242 F WIND

Display

15.00 / 242.0

When you are ready to start flight leg 2, merely:

Press

F ST.LEG, 2

Display

127.19 / 110.9



Instead of flying the displayed heading, assume you are flying a heading of 114° in order to stay on the radial from the VOR station. The wind is apparently different from what you assumed just before you started flight leg 2.

In the following example, monitor the display for the D/T Δ function to see where your Computer "thinks" you are at any given time. You must do this to make sure that you press the **POS Δ** key at a reasonable time in order to get a valid wind update. Therefore, just:

Press	Display
D/TΔ	31.8 0.13.55

After you have flown part of flight leg 2, you decide to update the wind vector. Suppose you recognize a bridge directly below, and you measure the distance from this bridge to your preceding checkpoint to be about 12 miles, using the chart. When the distance portion reaches 20 miles, the display shows:

20.00 0.08.45

Then, to inform the Computer of your current position and heading, just:

Press	Display
12 L 114	12. L 114.
F POSΔ	17.70 L 200.1

The updated wind is now displayed.

To see that the Computer has again recalculated distance and time to the next checkpoint, simply:

Press	Display
D/TΔ	20.4 0.09.41

NOTE: The new distance and time displayed is based on 21 miles left in this flight leg (33 mile leg - 12 miles) and the time when you pressed the **POS Δ** key. It is also based on the updated wind.

To see what the content of the In-flight wind register is now, simply:

Press	Display
WIND	17.70 L 200.1

OTHER USEFUL FUNCTIONS

The functions that are listed in this section of the Manual are typical navigation functions. There are instances where you may wish to use your Computer to add or subtract numbers in vector format. Also, you may want to find the reciprocal angle in a calculation. For these functions, refer to "Vector Arithmetic" on Page 87 and "Reciprocal Angle" on Page 83 of this Manual.

A FINAL REMINDER

The Computer is designed to be a valuable aid to the pilot. However, it is no substitute for good flight planning. In fact, if it is to be used to its full potential, good planning is absolutely essential. Although the Computer is capable of solving very complex navigation problems, in most respects it is still a "dumb machine." It possesses no common sense; you the pilot must provide that.

Each time you use the Computer, it calculates the answer very precisely based upon the data you enter into it. An incorrect VOR radial, a key entry mistake, or maybe just misreading the display produces an answer that looks "accurate" but is not correct. Your Computer does not know any better; however, you the pilot should. Always ask yourself if the displayed answers are reasonable.

Keep in mind the following rules when you use the Computer and you will be amply rewarded:

- Let the Computer be your servant, not your master.
- Do not be so busy "flying" your Computer that you forget to fly your plane.
- Allow yourself enough time to become familiar with the operation of your Computer so you do not have to search for the proper keys.
- Make sure you have a thorough understanding of each Computer function you use.



ADVANCED MATHEMATICS

Your Computer is primarily designed to execute all necessary computations for preflight, in-flight and navigational needs. However, it also functions as a powerful scientific calculator.

Calculating is faster and easier because the operational stack and the RPN used in this unit provide the most efficient way known to computer science for evaluating mathematical expressions.

The Computer is an extremely precise instrument. It will easily handle numbers as small as 10^{-99} and as large as 10^{99} . It automatically places the decimal point and allows 18 different options for rounding the display to provide greater flexibility and convenience in interpreting results. It provides you with transcendental functions; such as logarithms, sines, cosines and tangent. Furthermore, constants for π and e are provided, as well as nine addressable registers and a "last X" register.

Two-Number Functions

Two-number functions are functions that must have two numbers present in the Computer for the operation to be performed. $+$, $-$, \times , and \div are examples of two-number function keys. You cannot add, subtract, multiply, or divide unless two numbers have been entered into the Computer. Two-number functions operate in the same manner as the one-number functions — that is, the operation takes place when the function key is pressed.

When you must key more than one number into the Computer before it performs an operation, the **ENTER** key is used to separate the two numbers.

If you key in only one number, you never have to press the **ENTER** key. To place two numbers into the Computer and perform an operation, use the following procedure.

1. Key in the first number.
2. Press the **ENTER** key to separate the first number from the second.
3. Key in the second number.
4. Press the function key to perform the intended operation.

Always use the ENTER key when you must key more than one number into the Computer before you press a function.

For example, to add 18 and 3:

Press

18 The first number.

ENTER Separates the first number from the second.

3 The second number.

+ The function.

The answer, 21.00, is displayed.

Other arithmetic functions are performed the same way:

To perform	Press				Display
18 - 3	18	ENTER	3	-	15.00
18 × 3	18	ENTER	3	×	54.00
18 ÷ 3	18	ENTER	3	÷	6.00

Chain Calculations

The speed and simplicity of operation of the RPN logic system used in the OC-1401 Computer becomes most evident during chain calculations. Even when you perform the longest calculations, you still perform only one operation at a time, and you see the intermediate results as you calculate. The Heathkit Automatic Memory stack stores up to five intermediate results inside the Computer until you need them, then inserts them into the Computer. This logic system makes the operation of working through a problem as natural as it would be if you were working it out with pencil and paper, but the Computer takes care of the time-consuming work involved.

For example solve $(18 + 3) \times 9$

If you were going to solve the problem with a pencil and paper, you would first calculate the intermediate result of $(18 + 3) \dots$

$$\begin{array}{r} (18 + 3) \times 9 = \\ 21 \end{array}$$



... and then you would multiply the intermediate result by 9.

$$\begin{aligned} (18 + 3) \times 9 &= 189 \\ 21 \times 9 &= 189 \end{aligned}$$

You work through the problem exactly the same way with the Computer, one operation at a time. You calculate the *intermediate result* first...

$$(18 + 3)$$

Press	Display	
18	18.	
ENTER	18.00	
3	3.	
+	21.00	Intermediate result.

... and then solve for the final answer. You don't need to press ENTER to store the intermediate result — the Computer automatically stores it inside when you key in the next number. To continue...

Press	Display	
9	9.	The intermediate result from the preceding operation is automatically stored inside the Computer when you key in this number.
×	189.00	Pressing the function key multiplies the new number and the intermediate result, giving you the final answer.

Now try the following problems. Remember that for each problem, you only have to press ENTER to insert a pair of numbers into the Computer — each succeeding operation is performed by using a new number and an intermediate result that is being automatically stored.

To solve	Press	Display
$\frac{3 + 5}{10}$	3	
	ENTER	
	5	
	+	
	10	
	÷	0.80

To solve	Press	Display
$7(13 - 5)$	13	
	ENTER	
	5	
	-	
	7	
	x	56.00
$\frac{18 + 9 + 4 - 3}{8}$	18	
	ENTER	
	9	
	+	
	4	
	+	
	3	
	-	
	8	
	÷	3.50

Even more complicated problems can be solved in the same simple manner, by using the automatic storage of intermediate results. For example, to solve $(3 + 4) \times (2 + 6)$ with a pencil and paper, you would:

$$(3 + 4) \times (2 + 6)$$

First solve for the contents
of these parentheses ...

... and then for these parentheses ...

... and then multiply the two intermediate answers together.

Follow the same procedure when you work through the problem with the Computer. First you solve for the intermediate result of $(3 + 4)$...

Press	Display
3	3.
ENTER	3.00
4	4.
+	7.00
	Intermediate result.



Then add 2 and 6:

(Since you now must key in another pair of numbers before you can perform a function, you use the **ENTER** key again to separate the first number of the pair from the second.)

Procedure	Press	Display
$(3 + 4) \times (2 + 6)$ 7 8	2 ENTER 6 +	8.00

Then multiply the intermediate answers together for the final answer:

Procedure	Press	Display
$(3 + 4) \times (2 + 6)$ 7 \times 8	x	56.00

Note that it was not necessary to write down or key in the intermediate answers from inside each parentheses before you multiplied — the Computer automatically stacked up the intermediate results inside for you and brought them out when it was time to multiply.

No matter how complicated a problem may look, it can always be reduced to a series of one- and two-number operations. Just work through the problem in the same logical order you would use if you were working through it with pencil and paper.

For example, to solve:

$$\frac{(8 + 5) \times (6 + 3)}{(4 \times 5)}$$

Press	Display	
8 ENTER 5 +	13.00	Intermediate result of (8 + 5).
6 ENTER 3 +	9.00	Intermediate result of (6 + 3).
x	117.00	(8 + 5) multiplied by (6 + 3).
4 ENTER 5 x	20.00	Intermediate result of (4 x 5).
÷	5.85	The final answer.

Now try the following problems. Remember to work through them as you would with pencil and paper, but do not be concerned with the intermediate answers — they are handled automatically by the Computer.

$$(3 \times 4) + (5 \times 6) = 42.00$$

$$\frac{(17 + 11) \times (19 - 12)}{(7 - 5)} = 98.00$$

$$6 \times (19 - 11) \div (10 - 4) = 8.00$$

Display Control

In the Computer, you can select many different rounding options for display of numbers when you first turn the Computer on, for example, the Computer “wakes up” with the displayed numbers rounded to two decimal places. Thus, the fixed constant e , which is actually in the Computer as 2.71828183, will appear in the display as 2.72 (unless you inform the Computer to display the number rounded to a larger or fewer number of decimal places).

Although a number is ordinarily shown to only two decimal places, the Computer always computes internally, using each number as a 9-digit mantissa and a 2-digit exponent of 10. For example, when you compute 2×4 , you see the answer to only two decimal places:


Press	Display
2 ENTER 4 ×	8.00

However, inside the Computer all numbers have 9-digit mantissas and 2-digit exponents of 10. So the Computer actually calculates using full 9-digit numbers:


$2.00000000 \times 10^{00}$
ENTER
 $4.00000000 \times 10^{00}$
×

gives an answer that is actually carried to full 9 digits internally:

8.00000000 $\times 10^{00}$



You see only
these digits . .



. . but these digits are also present.



DISPLAY CONTROL KEYS

There are two keys, **FIX_n** and **SCI_n** that allow you to control the manner in which numbers appear in the display in the Computer. Prefix key **F** followed by the **FIX_n** key and the appropriate number key (0—8)* displays numbers in fixed decimal format, while **SCI_n** permits you to see numbers in scientific notation format.

No matter which format or how many displayed digits you choose, these display control keys change only the manner in which a number is displayed in the Computer. The actual number itself is not changed by pressing any of the display control keys. No matter what type of display you select, the Computer always calculates the results to its maximum accuracy. The results are internally computed to a 12-digit mantissa and a 2-digit exponent; then it is rounded off to the selected number of digits for display.** The maximum number of digits that can be displayed is eight in the mantissa and two in the exponent.

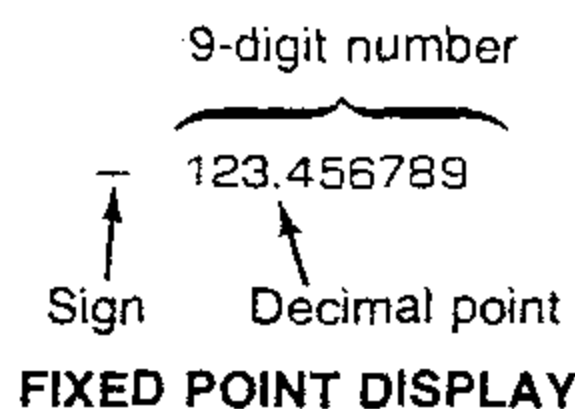
On the following pages, you will see how the **FIX_n** and **SCI_n** keys are used in conjunction with prefix keys **F** and **F⁻¹** and the number keys to display numbers in a wide variety of formats.

* Pressing number key 9 yields the same result as when you press key 8.

** An exception to this is when calculations involve numbers in vector format. In that case, the results are calculated to six digits for the magnitude and six digits for the angle.

FIXED POINT DISPLAY

After you turn your Computer on, the display you see is in FIX 2 notation — in other words, fixed point display with two decimal places shown. In fixed point display, numbers are shown with a fixed number of displayed digits after the decimal point. The number starts at the left side of the display and includes trailing zeros within the selected setting by the digit key. You can select fixed point display by pressing on the keyboard.



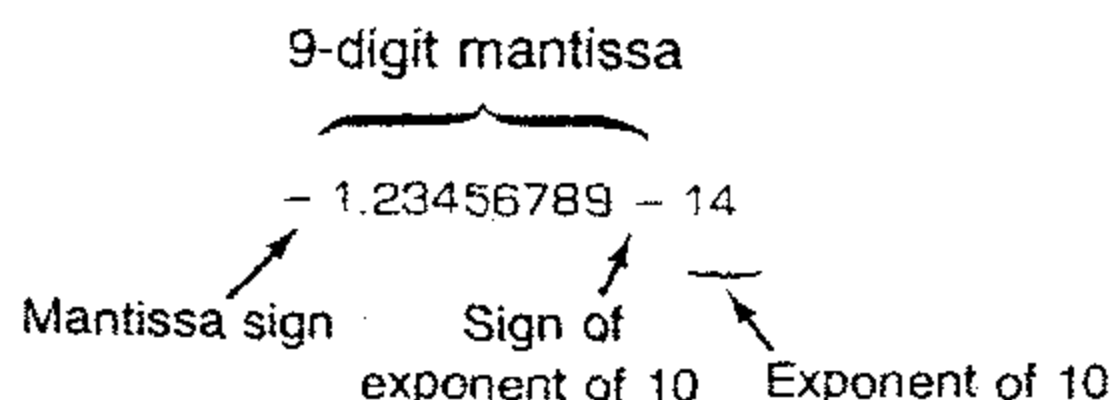
After you have specified fixed point format, you press the appropriate digit key (0-8) to select the number of places to which the display is rounded. For example:

Press	Display	
12.34567	<input type="text" value="12.34567"/>	
<input type="button" value="F"/> <input type="button" value="FIX<sub>n</sub>"/> 5	<input type="text" value="12.34567"/>	Display is rounded to the five decimal places you specified previously.
<input type="button" value="F"/> <input type="button" value="FIX<sub>n</sub>"/> 0	<input type="text" value="12"/>	
<input type="button" value="F"/> <input type="button" value="FIX<sub>n</sub>"/> 8	<input type="text" value="12.3456700"/>	NOTE: Only seven digits can be displayed after the decimal point as 9 digits plus decimal point is the limit.
<input type="button" value="F"/> <input type="button" value="FIX<sub>n</sub>"/> 3	<input type="text" value="12.346"/>	NOTE: The display rounds if the first hidden digit is 5 or greater.
<input type="button" value="F"/> <input type="button" value="FIX<sub>n</sub>"/> 2	<input type="text" value="12.35"/>	Normal FIX 2 display.



SCIENTIFIC NOTATION DISPLAY

In scientific notation, each number is displayed with a single digit to the left of the decimal point followed by a specified number of digits (up to eight) to the right of the decimal point and multiplied by a power of 10. Scientific notation is especially useful when working with very small or very large numbers.



SCIENTIFIC NOTATION DISPLAY

You can select scientific notation by pressing F^{-1} SCI_n on the keyboard. Then you must use a digit key to specify the number of decimal places to which the number is rounded. The display includes trailing zeros within the setting selected by the digit key. In order to change the number of places displayed after the decimal point, use the F^{-1} key followed by the SCI_n key and the appropriate digit key. For example:

Press	Display	
(Turn the Computer OFF, then ON.)	0.00	Computer "wakes up" with two places displayed after the decimal point.
12.34567	12.34567	
F^{-1} SCI_n 2	1.23 01	Displays 1.23×10^1 . Two decimal places as shown after decimal point.
F^{-1} SCI_n 4	1.2346 01	Displays 1.2346×10^1 . Notice that the display rounds off if the first hidden mantissa digit is 5 or greater.
F^{-1} SCI_n 8	1.23456700 01	Displays 1.23456700×10^1 .
F^{-1} SCI_n 9	1.23456700 01	Displays 1.23456700×10^1 . Notice that the display remains the same as when you pressed the "8" digit key.
F^{-1} SCI_n 4	1.2346 01	Displays 1.2346×10^1 .

AUTOMATIC DISPLAY SWITCHING

The Computer switches the display from fixed point notation to full scientific notation (SCI 8) whenever the number to be displayed is either too small or too large to be seen with a fixed decimal point. This feature prevents you from losing unforeseen small or large answers. For example, if you attempt to solve $(.03)^3$ in normal FIX 2 display, the answer is automatically shown in scientific notation.

Press		Display		
CLR X	F	FIX _n 2	0.00	Normal FIX 2 display.
.03	ENTER		0.03	
3	F ⁻¹	y ^x	2.70000000-05	Display is automatically switched to SCI 8 to show answer.

The display will automatically revert to the fixed point display, initially chosen when a new number, which is within the display limits of the mode chosen, is to be displayed.

The Computer will also switch to scientific notation if the answer is too large ($\geq 10^9$) for fixed point display. For example, the display will not switch to scientific notation if you solve 274300×1346 :

Press		Display	
274300	ENTER	274300.00	
1346	×	369207800.	Fixed point format.

However, if you multiply the result by 10, the answer will be too large for fixed point notation, and the Computer display switches automatically to scientific notation:

Press		Display	
10	×	3.69207800 09	Scientific notation format.



KEYING IN EXPONENTS OF TEN

You can key in numbers multiplied by powers of 10 by pressing **EN EXP** (enter exponent of 10) followed by number keys to specify the exponent of 10. For example, 37.6 billion (37.6×10^9), multiplied by 75:

Press	Display	
37.6	37.6	
EN EXP	37.6 00	
9	37.6 09	(This means 37.6×10^9 .)
Then Press	Display	
ENTER	3.76000000 10	
75 x	2.82000000 12	

When you key in exact powers of 10, you can save time by just pressing the **EX EXP** key and then press the desired power of 10. For example, key in 1 million (10^6) and divide by 64.

Press	Display
EN EXP	1.00 00
6	1.00 06
ENTER	1000000.00
64 ÷	15625.00

NOTE: It is not necessary to key in the number 1 before you press the **EN EXP** key when the number is an exact power of 10.

Since you did not specify scientific notation before you pressed the **EN EXP** key, the number will revert to fixed point notation when you press **ENTER**.

To see this number in scientific notation with four decimal places:

Press	Display
F^{-1} SCI_n 4	1.5825 04

To key in negative exponents of 10, key in the number, press $EN\ EXP$, press CHS to make the exponent negative, then key in the power of 10. For example, key in Boltzman's constant (k) — approximately, 1.38×10^{-16} erg/deg — and multiply it by 25.

Press	Display
$CLR\ X$	0.0000 00
F FIX_n 2	0.00
1.38 $EN\ EXP$	1.38 00
CHS	1.38 -00
16	1.38 -16
$ENTER$	1.38000000 -16
25 \times	3.45000000 -15 Erg/deg.

COMPUTER OVERFLOW

When the result of a calculation exceeds $9.99999999 \times 10^{99}$, the Computer displays all 9's to indicate that the Computer's range has been exceeded. For example, if you attempt to solve $(1 \times 10^{33}) \times (1 \times 10^{66})$, the Computer will display the answer:

Press	Display
$CLR\ X$	0.00
$EN\ EXP$ 33 $ENTER$	1.00000000 33
$EN\ EXP$ 66 \times	1.00000000 99

However, if you try to multiply the above result by 10, the Computer display indicates overflow by showing all 9's:

Press	Display
10 \times	9.99999999 99 Overflow indication.



Automatic Memory Stack

NOTE: In the following discussion, it is important to realize that the "X-register" is always considered the content of the display.

1. Slide the NORMAL-STANDBY switch to NORMAL.
2. Slide the OFF-ON switch to OFF, then to ON.



The displayed X-register, which is the only visible register, is one of five registers inside the Computer that are positioned to make up the automatic memory stack. These registers are labeled X, Y, Z, S and T. They are "stacked" one on top of the other with the displayed X-register on the bottom. When the Computer is turned on, these five registers are cleared to zero.

Basically, numbers are stored and manipulated in the "registers" of the Computer. Each number, regardless of how few digits (for example, 0, 3, or 7) or how many (for example 2.71828183, — 34,27698, or 3.3417906×10^{21}), occupies one complete register.


Name	Register
S	0.00
T	0.00
Z	0.00
Y	0.00
X	0.00

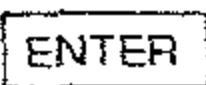


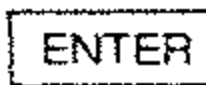
Always displayed.

MANIPULATING STACK CONTENTS

The  (roll down) and  (x exchange y) keys permit you to review the contents of the stack or to shift data within the stack for computation at any time.

Reviewing the Stack Contents

To see how the  key works, first load the stack with numbers 1 through 5 by pressing:

5  4  3  2  1

The numbers that you keyed in are now loaded into the stack, and its contents look as follows:

S	5.00
T	4.00
Z	3.00
Y	2.00
X	1.

Display.

When you press **F⁻¹** **R ▼**, the stack contents shift downward one register. So the last number that you have keyed in will be rotated around to the S-register when you press **F⁻¹** **R ▼**. When you press **F⁻¹** **R ▼** again, the stack contents again roll downward one register.

When you press **F⁻¹** **R ▼**, the stack contents are rotated ...

... from this ...

S	5.00
T	4.00
Z	3.00
Y	2.00
X	1.

Display.

... to this.

S	1.00
T	5.00
Z	4.00
Y	3.00
X	2.00

Display.

NOTE: Only the **contents** of the registers are shifted. The registers themselves maintain their positions. The contents of the X-register are always displayed, so **2.00** is now visible.

Again press **F⁻¹** **R ▼** and the stack contents are shifted ...

... from this ...

S	1.00
T	5.00
Z	4.00
Y	3.00
X	2.00

Display.

... to this.

S	2.00
T	1.00
Z	5.00
Y	4.00
X	3.00

Display.

Press **F⁻¹** **R ▼** once more and the stack shifts ...

... from this ...

S	2.00
T	1.00
Z	5.00
Y	4.00
X	3.00

Display.

... to this.

S	3.00
T	2.00
Z	1.00
Y	5.00
X	4.00

Display.



Press **F-1** **R ▾** twice more and the stack shifts ...

... through this ...

S	4.00
T	3.00
Z	2.00
Y	1.00
X	5.00

Display.

... back to the start.

S	5.00
T	4.00
Z	3.00
Y	2.00
X	1.00

Display.

Exchanging x and y

The **X \rightleftharpoons Y** (x exchange y) key exchanges the contents of the X- and the Y-registers without affecting the Z-, T-, and S-registers. If you press **F** **X \rightleftharpoons Y**, with data intact from the last example, the number in the X-register will be exchanged with the number in the Y-register ...

... from this ...

S	5.00
T	4.00
Z	3.00
Y	2.00
X	1.00

Display

... to this.

S	5.00
T	4.00
Z	3.00
Y	1.00
X	2.00

Display.

In the same manner, pressing **F** **X \rightleftharpoons Y** again will restore the numbers in the X- and Y-registers to their original places. This function can be used to position numbers in the stack to transfer the contents of Y-register into the X-register for display.

NOTE: When you move numbers in the stack using one of the data manipulation keys, the stack registers themselves maintain their positions. Only the contents of the registers are shifted. The contents of the X-register are always displayed.

CLEARING THE DISPLAY

When you press **CLR X** (clear x), the displayed X-register is cleared to zero. No other register is affected when you press **CLR X**.

Press **CLR X** now and the stack contents are changed ...

... from this ...

S	5.00
T	4.00
Z	3.00
Y	1.00
X	2.00

Display.

... to this.

S	5.00
T	4.00
Z	3.00
Y	1.00
X	0.00

Display.

NOTE: It is not necessary to clear the displayed X-register when you start a new calculation. This will become evident when you see how old results in the stack are moved out when you make new entries.

THE "ENTER" KEY

When you key a number into the Computer, its contents are written into the displayed X-register. For example, if you key in the number 256.73 at this time, you can see that the display contents are changed.

When you key in 256.73, with the stack contents unaltered from the preceding examples, the contents of the stack registers are changed . . .

. . . from this . . .

S	5.00
T	4.00
Z	3.00
Y	1.00
X	0.00

Display.

. . . to this.

S	5.00
T	4.00
Z	3.00
Y	1.00
X	256.73

Display.

In order to key in another number at this point, you must first terminate digit entry — that is, you must let the Computer know that you have completed keying in the first number and that any new digits you key in are part of a new number.

Use the **ENTER** key to separate the first number from the second.

When you press the **ENTER** key, the contents of the stack registers are changed . . .

. . . from this . . .

S	5.00
T	4.00
Z	3.00
Y	1.00
X	256.73

Display.

. . . to this.

S	4.00
T	3.00
Z	1.00
Y	256.73
X	256.73

Display.

Notice that the number in the X-register is copied into the Y-register. The numbers in Y, Z, and T have also been copied into the Z, T, and S-registers respectively. The number in the S-register has been lost off the top of the stack.

As soon as you have pressed the **ENTER** key, the X-register is ready for a new number, and that new number writes over the number present in the X-register. For example, key in the number 738.69. The contents of the stack registers the change . . .

. . . from this . . .

S	4.00
T	3.00
Z	1.00
Y	256.73
X	256.73

Display.

. . . to this.

S	4.00
T	3.00
Z	1.00
Y	256.73
X	738.69

Display.



The **CLRX** key replaces any number in the display with zero. When you key in a new number, it writes over the zero in the X-register.

If you, for example, had intended to key in 425.9 instead of 738.69, you would now press **CLRX** to change the stack...

... from this ...

S	4.00
T	3.00
Z	1.00
Y	256.73
X	738.69

Display.

... to this.

4.00
3.00
1.00
256.73
0.00

Display.

Now key in 425.9 to change the stack...

... from this ...

S	4.00
T	3.00
Z	1.00
Y	256.73
X	0.00

Display.

... to this.

S	4.00
T	3.00
Z	1.00
Y	256.73
X	425.9

Display.

NOTE: The numbers in the stack do not move when you key in a new number right after you press the **ENTER** or the **CLRX** key. However, the numbers in the stack do lift upward when a new number is keyed in right after you press most other functions, including **F⁻¹**, **R_↓** and **F** **X_{→y}**.

ONE-NUMBER FUNCTIONS AND THE STACK

One-number functions only perform upon the number in the X-register, and the contents of the Y-, Z-, T-, and S-registers are not affected when you press a one-number function key.

For example, with the stack contents unaltered from the previous example, pressing **F** **√x** changes the stack contents...

... from this ...

S	5.00
T	4.00
Z	3.00
Y	256.73
X	425.9

Display.

... to this.

S	5.00
T	4.00
Z	3.00
Y	256.73
X	20.64

Display.

TWO-NUMBER FUNCTIONS AND THE STACK

The Computer makes arithmetic calculations by placing the numbers in the stack the same way you would write them on paper. For example, if you wanted to add 46 and 17, you would first write 46 down on the paper and then write 17 underneath it, like this:

$$\begin{array}{r} 46 \\ 17 \\ \hline \end{array}$$

Then you would add these numbers, like this:

$$\begin{array}{r} 46 \\ + 17 \\ \hline 63 \end{array}$$

Numbers are placed the same way in the Computer. The following example explains how it is done. NOTE: As you already know, you do not have to remove previous results from the stack before you begin a new calculation. However, in order to better understand the example, you may wish to press the **CLR X** and **ENTER** keys to fill the stack with zeros.

Press	Display
CLR X	0.00
ENTER	0.00
ENTER	0.00
ENTER	0.00
ENTER	0.00
46	46.
ENTER	46.00
17	17.

S	0.00
T	0.00
Z	0.00
Y	46.00
X	17.

Display.

Press	Display
+	63.00

The answer.



The stack contents is now as shown below.

S	0.00	46 and 17 are added together for the final answer. At the same time the content of the Z-register drops down into the Y-register.
T	0.00	
Z	0.00	
Y	0.00	
X	63.00	

CHAIN ARITHMETIC

At this time, you know how to key numbers into the Computer and perform calculations with them. In each case, you first had to place the numbers in the stack manually using the **ENTER** key. But the stack also performs many automatic movements. It is these movements that automatically store intermediate results. Whenever you key in a new number, the stack automatically "lifts" every calculated number in the stack because the Computer knows that after it completes a calculation, any new digits you key in are part of a new number. Furthermore, the stack automatically "drops" when you perform a two-number operation.

To see how this operates, solve

$$17 + 24 + 35 + 19 + 48 = ?$$

You may wish to press the **CLRX** key first to begin with zeros in all the stack registers. However, this is not absolutely necessary, as you can also perform the calculation without first clearing the stack.

Press	Stack Contents		
17	S	0.00	17 is keyed into the displayed X-register
	T	0.00	
	T	0.00	
	Y	0.00	
	X	17.	
ENTER	S	0.00	17 is entered into the Y-register.
	T	0.00	
	Z	0.00	
	Y	17.00	
	X	17.00	
24	S	0.00	24 writes over 17 in the X-register.
	T	0.00	
	Z	0.00	
	Y	17.00	
	X	24.	

+	S	0.00	24 and 17 are added together. The answer, 41, is displayed.
	T	0.00	
	Z	0.00	
	Y	0.00	
	X	41.00	
35	S	0.00	35 is keyed into the displayed X-register. The 41 in the stack is automatically lifted.
	T	0.00	
	Z	0.00	
	Y	41.00	
	X	35.	
+	S	0.00	41 and 35 are added together. The answer, 76, is displayed.
	T	0.00	
	Z	0.00	
	Y	0.00	
	X	76.00	
19	S	0.00	19 is keyed into the X-register. 76 is automatically transferred into the Y-register.
	T	0.00	
	Z	0.00	
	Y	76.00	
	X	19.	
+	S	0.00	76 and 19 are added together. The answer, 95, is displayed.
	T	0.00	
	Z	0.00	
	Y	0.00	
	X	95.00	
48	S	0.00	48 is keyed into the X-register. 95 is automatically transferred into the Y-register.
	T	0.00	
	Z	0.00	
	Y	95.00	
	X	48.00	
+	S	0.00	95 and 48 are added together for the final answer.
	T	0.00	
	Z	0.00	
	Y	0.00	
	X	143.00	

After you make any calculation or number manipulation, the stack automatically lifts when you key in a new number. In addition, the stack automatically drops during calculations that affect both X- and Y-registers. This happened in the last example, but now this problem will be solved in a different way to show this feature more clearly. For clarity, first clear the X-register by pressing the **CLR X** key. Again solve $17 + 24 + 35 + 19 + 48 = ?$



Press

Stack Contents

17

S	0.00
T	0.00
Z	0.00
Y	0.00
X	17.

17 is keyed into the
displayed X-register.

ENTER

S	0.00
T	0.00
Z	0.00
Y	17.00
X	17.00

17 is copied into
the Y-register.

24

S	0.00
T	0.00
Z	0.00
Y	17.00
X	24.

24 is written over the
17 in the X-register.

ENTER

S	0.00
T	0.00
Z	17.00
Y	24.00
X	24.00

24 is copied into the
Y-register. 17 is lifted
up to the Z-register.

35

S	0.00
T	0.00
Z	17.00
Y	24.00
X	35.

35 is keyed into the
displayed X-register.

ENTER

S	0.00
T	17.00
Z	24.00
Y	35.00
X	35.00

35 is entered into the
Y-register. 24 and 17
are lifted up to the
Z- and T-registers respectively.

19

S	0.00
T	17.00
Z	24.00
Y	35.00
X	19.

19 is keyed into the
displayed X-register.

ENTER

S	17.00
T	24.00
Z	35.00
Y	19.00
X	19.00

19 is copied into the Y-
register. 35 is lifted up
to the Z-register. 24 and
17 are lifted up to the T-
and Z-registers respectively.

48		S	17.00	
		T	24.00	
		Z	35.00	
		Y	19.00	48 is written over the
		X	48.	19 in the X-register.
	+	S	17.00	
		T	17.00	48 and 19 are added together
		Z	24.00	and the rest of the stack
		Y	35.00	drops. 17 drops to the T-register
		X	67.00	and is also duplicated in the
				S-register. 24 drops to the Z-
				register. 35 and 67 are ready
				to be added.
	+	S	17.00	
		T	17.00	35 and 67 are added together
		Z	17.00	and the stack drops again.
		Y	24.00	Now 24 and 102 are ready
		X	102.00	to be added.
	+	S	17.00	
		T	17.00	24 and 102 are added together
		Z	17.00	and the stack drops again.
		Y	17.00	Now 17 and 126 are ready to
		X	126.00	be added.
	+	S	17.00	
		T	17.00	17 and 126 are added for the final
		Z	17.00	answer and the stack continues
		Y	17.00	to drop.
		X	143.00	

The same dropping action also takes place with the other arithmetic operators $-$, \times and \div . The number in S is duplicated in S and drops to T, the number in T drops to Z, the number in Z drops to Y, and the numbers in the Y- and X-registers combine to give the final answer. This answer is then visible in the displayed X-register.

The automatic lift and drop of the registers in the stack give you great computing power, since you can keep intact and position intermediate results during long calculations without the need for reentering the numbers.



ORDER OF EXECUTION

When you are faced with a problem like the following:

$9 \times [(4 \times 7) + (6 \div 4) - (5 \div 3)] \div (3.5 \times 1.346)$, you must decide where to start before you press any key.

In order to take full advantage of the efficiency and power of your Computer, it is best to start every problem at its innermost number or parentheses and work outward, just as you would with pencil and paper. Of course, with the Computer you have tremendous versatility in the order of execution.

For instance, you could work the problem given above by beginning at the left side of the equation and work through it in left-to-right order. However, it is not always possible to solve a problem in this manner. The best order for solving any problem is to start with the innermost parentheses and work outward. So, to solve the problem given above:

Press	Display	
4	4.	
ENTER	4.00	
7	7.	
x	28.00	Intermediate answer for (4×7) .
6	6.	
ENTER	6.00	
4	4.	
÷	1.50	Intermediate answer for $(6 \div 4)$.
+	29.50	Intermediate answer for $(4 \times 7) + (6 \div 4)$.
5	5.	
ENTER	5.00	
3	3.	
÷	1.67	Intermediate answer for $(5 \div 3)$.
-	27.83	Intermediate answer for $(4 \times 7) + (6 \div 4) - (5 \div 3)$.
3.5	3.5	
ENTER	3.50	
1.346	1.346	
x	4.71	Intermediate answer for (3.5×1.346) .
÷	5.91	
9	9.	The first number is keyed in.
x	53.17	The final answer.

WEIGHT AND BALANCE CALCULATION

Calculating weight and balance of an airplane illustrates the use of the operational stack in a mathematics problem. The following is a representative example of such a calculation.

	Weight (lbs)	Arm (inches from datum)
Licensed Empty Weight*:	1378	82.18
Oil (8 qts):	15	32.0
Fuel (45 gal @ 6 lbs per gal):	270	95.0
Pilot and front seat passenger:	360	91.0
Rear seat passengers:	275	126.0
Baggage:	42	151.0

$$\text{Total Moment (lb} \cdot \text{in)} = (1378 \times 82.18) + (15 \times 32) + (270 \times 95) + (360 \times 91) + (275 \times 126) + (42 \times 151)$$

To perform this calculation:

Press	Display
1378	
ENTER	
82.18	
\times	113244.04
15	
ENTER	
32	
\times	480.00
$+$	113724.04
270	
ENTER	
95	
\times	25650.00
$+$	139374.04
360	
ENTER	
91	
\times	32760.00
$+$	172134.04

*Total weight of airplane, undrainable oil, and unusable fuel.



Press	Display
275	
ENTER	
126	
x	34650.00
+	206784.04
42	
ENTER	
151	
x	6342.00
+	213126.04
	Total moment in lb • in.

Total Weight (lbs) = 1378 + 15 + 270 + 360 + 275 + 42

To perform this calculation:

Press	Display
1378	
ENTER	
15	
+	
270	
+	
360	
+	
275	
+	
42	
+	2340.00
	Total weight in lbs.

You must now compare this data with the center of gravity envelope for the airplane you intend to fly. This must be done to insure that you will be operating within this envelope.

If you wish to calculate the "Center of Gravity Point", proceed as follows:

$$\text{Center of Gravity Point (inches)} = \frac{\text{Total Moment}}{\text{Total Weight}} = \frac{213126}{2340}$$

To perform this calculation:

Press

Display

213126

ENTER

2340

÷

91.08

Center of gravity point in inches.

LAST X REGISTER

The Computer also contains a separate automatic register called the LAST X register. This register preserves the value that was in the displayed X-register before a function is performed. To place the contents of the LAST X register into the display again, press **F** **LST X**.

CORRECTING INPUT ERRORS

Using the **LST X** key makes it easy to correct keystroke mistakes, such as pressing an incorrect function key or entering an incorrect number. If you want to correct a number in a long calculation, this key can save you from starting over. For example, divide 37 by 6.843 after you have divided by 5.843 in error.

Press

Display

37

37.

ENTER

37.00

5.843

÷

6.33

You wanted to divide by 6.843 not 5.843.

F

LST X

5.84

Retrieves that last entry (5.843).

×

37.00

You're back at the beginning.

6.843

÷

5.41

The correct answer.



Function Keys

RECIPROCAL

To calculate the reciprocal of a number in the displayed X-register, key in the number, then press **F** **$1/x$** . For example, to calculate the reciprocal of 20:

Press	Display
20 F $1/x$	0.05

You can also calculate the reciprocal of a value in a previous calculation without reentering the number. For example, calculate

$$\frac{1}{1/5 + 1/7 + 1/9}$$

Press	Display
5 F $1/x$	0.20
7 F $1/x$	0.14
+	0.34
9 F $1/x$	0.11
+	0.45
F $1/x$	2.20

Sum of reciprocals

The reciprocal of the sum of the reciprocals yields the answer.

RECIPROCAL ANGLE

To calculate the reciprocal of an angle in the displayed X-register, key in the angle, then press **F** **RCP \angle** . For example, to calculate the reciprocal angle of 270°:

Press	Display
270	270.
F RCP \angle	90.00

FINDING SQUARE ROOTS

To calculate the square root of a displayed number, press **F** **\sqrt{x}** . For example, find the square root of 81:

Press	Display
81 F \sqrt{x}	9.00

Now find the square root of the result:

Press	Display
\boxed{F} $\boxed{\sqrt{x}}$	$\boxed{3.00}$

SQUARING NUMBERS

To square a number in the displayed X-register, press $\boxed{F^{-1}}$ $\boxed{x^2}$. For example, what is the square of 18?

Press	Display
18 $\boxed{F^{-1}}$ $\boxed{x^2}$	$\boxed{324.00}$

Now find the square of the result:

$\boxed{F^{-1}}$ $\boxed{x^2}$	$\boxed{104976.00}$
--------------------------------	---------------------

USING π

The value π , accurate to nine places (3.14159265), is one of the fixed constants provided in the Computer. Just press $\boxed{F^{-1}}$ $\boxed{\pi}$ when you need it in a calculation. For example, to calculate 4π :

Press	Display
4 $\boxed{F^{-1}}$ $\boxed{\pi}$ $\boxed{\times}$	$\boxed{12.57}$

NOTE: Here the "4" does not have to be entered since " π " is recognized as a separate number and lifts the stack.

TRIGONOMETRIC FUNCTIONS

The following trigonometric functions are provided:

\boxed{F}	$\boxed{\text{SIN}}$	(sine)
$\boxed{F^{-1}}$	$\boxed{\text{SIN}^{-1}}$	(arc sine)
\boxed{F}	$\boxed{\text{COS}}$	(cosine)
$\boxed{F^{-1}}$	$\boxed{\text{COS}^{-1}}$	(arc cosine)
\boxed{F}	$\boxed{\text{TAN}}$	(tangent)
$\boxed{F^{-1}}$	$\boxed{\text{TAN}^{-1}}$	(arc tangent)

All trigonometric functions are one-number functions, so to use them, you first key in the number, then press the function keys.

EXAMPLE 1: Find the sine of 60° .

Press	Display
60	$\boxed{60.}$
\boxed{F} $\boxed{\text{SIN}}$	$\boxed{0.87}$



EXAMPLE 2: Find the tangent of 30° .

Press	Display
30	30.
F TAN	0.58

EXAMPLE 3: Find the arc cosine of .707.

Press	Display
.707	.707
F⁻¹ COS⁻¹	45.01

Degrees.

DECIMAL HOURS/HOURS, MINUTES, SECONDS CONVERSIONS

You can change time specified in decimal hours to hours, minutes, seconds format by using the **F** **►HMS** keys. You can also change from hours, minutes, seconds to decimal hours by using the **F⁻¹** **H◄** keys.

NOTE: When a time is displayed in hours, minutes, seconds format, the digits specifying hours occur to the left of the first decimal point, while the digits specifying minutes occur between the first and the second decimal points. The digits specifying seconds and tenths of seconds occur to the right of the second decimal point.

To convert from decimal hours to hours, minutes, seconds, first key in the value for decimal hours; then press **F** **►HMS**. For example, to change 18.43 hours to hours, minutes, seconds:

Press	Display
18.43	18.43
F ►HMS	18.25.47

Key in the decimal time.

This is 18 hours, 25 minutes, 47 seconds.

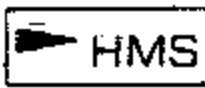
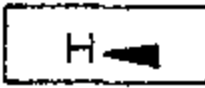
NOTE: The display is automatically switched to show time format.

To convert from hours, minutes, seconds to decimal hours, simply key in the value for hours, minutes, seconds in time format and press **F⁻¹** **H◄**. For example, to convert 125 hours, 37 minutes, and 16.28 seconds to its decimal degree equivalent:

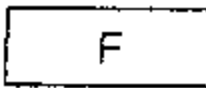
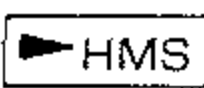
Press	Display
125.37.1628	125.37.1628
F⁻¹ H◄	125.62

This is 125 hours, 37 minutes, 16.28 seconds.

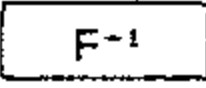
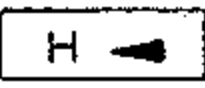
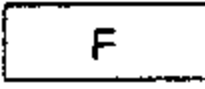
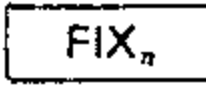
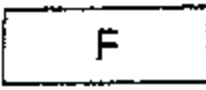

This is 125.62 hours.

By using the  and  operations, you can also convert angles specified in decimal degrees to degrees, minutes, seconds of arc, and vice versa. The format for degrees, minutes, seconds is the same as for hours, minutes, seconds.

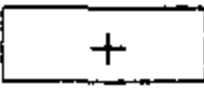
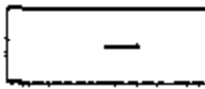
Example: Convert 67.43 decimal degrees to degrees, minutes, seconds.

Press	Display	
67.43	67.43	Key in the angle.
 	67.25.48	This is 67° 25' 48".

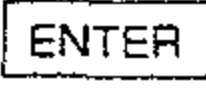
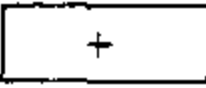
Example: Convert 43° 14' 53.6" to its decimal equivalent.

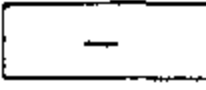
Press	Display	
43.14.536	43.14.536	Key in the angle.
 	43.25	Answer shown in decimal degrees.
  4	43.2482	If more accuracy is needed.
  2	43.25	

ADDING AND SUBTRACTING TIME

To add or subtract hours, minutes, and seconds, just key in the numbers for the hours, minutes, and seconds and press  or .

Example: Find the sum of 39 hours, 7 minutes, 40.96 seconds and 10 hours, 52 minutes, 23.17 seconds

Press	Display
39.07.4096	39.07.4096
	39.07.40
10.52.2317	10.52.2317
	50.00.04

To subtract a time in hours, minutes, seconds from another, use the  key to make the second time negative.



Example: Subtract 35.76 hours from 62 hours, 37 minutes, 8 seconds, with the answer in hours, minutes, seconds format.

Press	Display	
62.37.08	62.37.08	
ENTER	62.37.08	
35.76	35.76	Decimal time.
F →HMS	35.45.36	To hours, minutes, seconds.
-	26.51.32	This is 26 hours, 51 minutes, 32 seconds.

VECTOR ARITHMETIC

To add or subtract numbers in vector format, simply press the keys for each vector and press **+** or **-**.

Example: Suppose you want to find the equivalent (rhumb line) vector of the two flight legs 34 miles $\angle 98^\circ$ and 23 miles $\angle 134^\circ$. See Pictorial 4-5.

Press	Display	
34 ∠ 98 ENTER	34.00 \angle 98.00	
23 ∠ 134	23. \angle 134.	
+	54.32 \angle 112.4	The equivalent vector



PICTORIAL 4-5

LOGARITHMIC AND EXPONENTIAL FUNCTIONS

Logarithms

The Computer computes both common and natural logarithms as well as their inverse functions (antilogarithms):

F LOG	is \log_{10} (common log). It takes the log of the value in the X-register to base 10.
F⁻¹ 10^x	is antilog_{10} (common antilog). It raises 10 to the power of the value in the X-register.
F LN	is \log_e (natural log). It computes the log of the value in the X-register to base e (2.718...).
F⁻¹ e^x	is antilog_e (natural antilog). It raises e (2.718...) to the power of the value in the X-register.



As with all other single number functions, each function is performed on the contents of the X-register. To use these functions, you first key in the number, then press the function keys.

EXAMPLE 1: Find the common logarithm of 23.

Press	Display
23	23.
\boxed{F} \boxed{LOG}	1.36

EXAMPLE 2: Find the common antilogarithm of 2.45.

Press	Display
2.45	2.45
$\boxed{F^{-1}}$ $\boxed{10^x}$	281.84

EXAMPLE 3: Find the natural logarithm of 7.23.

Press	Display
7.23	7.23
\boxed{F} \boxed{LN}	1.98

EXAMPLE 4: Find the natural antilogarithm of 4.83.

Press	Display
4.83	4.83
$\boxed{F^{-1}}$ $\boxed{e^x}$	125.21

RAISING NUMBERS TO POWERS

You use the $\boxed{y^x}$ key when you raise numbers to powers. By using $\boxed{F^{-1}}$ $\boxed{y^x}$ you may raise a positive real number to any real power — that is, the power may be positive or negative, and it may be an integer, a fraction, or a mixed number. $\boxed{F^{-1}}$ $\boxed{y^x}$ also allows you to raise any negative real number to the power of any integer (within the range of the Computer).

For example, to calculate 2^7 (that is $2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2$):

Press	Display
2 ENTER	2.00
7	7.
F^{-1} y^x	128.00

To calculate $(3.84)^3$

Press	Display
3.84 ENTER	3.84
3	3.
F^{-1} y^x	56.62

To calculate $3^{-2.965}$

Press	Display
3 ENTER	3.00
2.965 CHS	-2.965
F^{-1} y^x	0.04

Using y^x , in conjunction with the $1/x$ key, makes it simple to extract roots. For example, find the cube root of 12. (This is equivalent to $12^{1/3}$.)

Press	Display	
12 ENTER	12.00	
3 F $1/x$	0.33	Reciprocal of 3.
F^{-1} y^x	2.29	Cube root of 12.

Storing and Recalling Numbers

In addition to the automatic storage of intermediate results that is provided by the stack, the Computer also contains nine addressable data storage registers that are not affected by operations within the stack. These storage registers allow you to manually store and recall constants or to set aside numbers for use in later calculations.

STORAGE REGISTERS

The following illustration shows the addressable storage registers. The subscripts 1 through 9 refer to the register addresses.

Automatic Memory Stack

S
 T
 Z
 Y
 X

LAST X

Addressable Storage Registers

R₉
 R₈
 R₇
 R₆
 R₅
 R₄
 R₃
 R₂
 R₁

Storing Numbers

To store a displayed number in storage registers R₁ through R₉:

1. Press .
2. Press the number key (through) of the desired register address.

Assume that you want to store the elapsed time for a specific event in one of the storage registers; that is, the time it takes from the moment you start the clock till that event happens.

For example, to store the elapsed time for an event that happens 12 minutes and 30 seconds after you started the elapsed time (ET) clock in register R₅:

Press	Display
<input type="text" value="F"/> <input type="text" value="ET"/>	<input type="text" value="0.12.30"/>
<input type="text" value="F"/> <input type="text" value="STO"/> 5	<input type="text" value="0.12.30"/>

This time is now stored in register R₅. You can see that when a number is stored, it is just copied into the storage register, so 12.30 also remains in the displayed X-register.



In a similar manner, you may also store dynamic displays for true time (CLK) and the distance and time functions (ΔT and $\Delta T \text{ DES}$) in any of the nine addressable storage registers.

Recalling Numbers

Numbers are recalled from the storage registers back into the displayed X-register in about the same manner as they are stored. To recall a number from any of the storage registers R_1 through R_9 :

1. Press F RCL.
2. Press the number key (1 through 9) of the desired storage register address.

For example, to recall the time of the particular event that happened from register R_5 :

Press			Display
F	RCL	5	0.12.30

When you recall a number, it is copied from the storage register into the displayed X-register, and it also remains in the storage register. You can recall a number from a storage register any number of times without altering it — the number will remain in the storage register as a 9-digit number with a 2-digit exponent of 10 until you overwrite it by storing another number there, or until you turn the Computer off.

CLEARING STORAGE REGISTERS

Even though you have recalled the contents of a storage register into the displayed X-register, the number also remains in the storage register. You can clear the storage registers as follows:

To replace a number in a single storage register, just store another number there. To clear a storage register replace the numbers in it with zero. For example, to clear storage register R_5 :

Press			Display
0	F	STO 5	0.00

Then recall the number in register R_5 :

Press			Display	
F	RCL	5	0.00	R_5 contents have been cleared to zero.

IMPROPER OPERATIONS

If you try to perform a calculation that contains an improper operation, the calculator will display Error You may clear the "Error" display by pressing any Computer key. The list below is a summary of improper operations.

\sqrt{x} where $x < 0$

y^x where $y < 0$

LOG where $x \leq 0$

LN where $x \leq 0$

\sin^{-1} where $|x|$ is > 1

\cos^{-1} where $|x|$ is > 1

\times , \div , y^x where x and y are in time format

$+$, $-$ where x (or y) is in time format and y (or x) is not in time format

y^x where x or y is in vector format

\sqrt{x} , x^2 , 10^x , e^x ,
SIN, COS, TAN, \sin^{-1} ,
 \cos^{-1} , \tan^{-1} , LOG, LN,
MI \rightleftarrows NAUT, $^{\circ}\text{F} \rightleftarrows ^{\circ}\text{C}$, GAL \rightleftarrows LTR,
MI \rightleftarrows KM, RCP L, \rightarrow HMS

} where x is in time format

SIN, COS, TAN, \sin^{-1} , \cos^{-1} ,
 \tan^{-1} , LOG, LN, 10^x , e^x ,
H \rightleftarrows HMS, $^{\circ}\text{F} \rightleftarrows ^{\circ}\text{C}$, GAL \rightleftarrows LTR,

} where x is in vector format

H \leftarrow , SET where x is not in time format

Any function except data manipulation where x is in distance/time format

NOTE: It is possible for an "error" display to occur when you use certain flight functions. This will happen when you operate on unrealistic Computer data in these complex functions. For example, let's say you pressed the Δ key a few seconds after the start of several mile long flight leg. This would possibly imply a tail wind or several hundred miles an hour, which of course is unreasonable. As a result, you would see "Error" displayed.



IN CASE OF DIFFICULTY

This section of the Manual is divided into two parts. The first part, titled "General Troubleshooting Information," describes what to do about the difficulties that may occur right after your Computer is assembled.

The second part, titled "Troubleshooting Chart," is provided to assist you in servicing the Computer if the "General Troubleshooting Information" fails to clear up the problem, or if difficulties occur after your Computer has been in use for some time. The "Troubleshooting Chart" lists a number of possible difficulties that could arise along with several possible solutions to those difficulties.

Try to analyze the symptoms of any problem you might have before starting any troubleshooting procedure. You can usually accomplish this by trying the various functions of your Computer to determine abnormal operations. A review of the Operation section may help your analysis.

NOTE: Refer to the "Circuit Board X-Ray View" on Page 99 for the physical location of parts on the circuit boards.

GENERAL TROUBLESHOOTING INFORMATION

1. Check all the wires that are connected between the circuit boards and other parts. Trace each wire in colored pencil on the Pictorial as it is checked. Make sure these wires are connected to the proper points and are properly soldered. Someone who is not familiar with the unit may notice something you have consistently overlooked.
2. About 90% of the kits that are returned for repair do not function properly because of poor connections and soldering. Therefore, you can locate many troubles by a careful inspection of connections to make sure they are soldered as described in the "Soldering" section of the "Assembly Notes." Reheat any doubtful connections.
3. Closely examine each circuit board foil in a good light to see that no solder bridges exist between adjacent connections. The magnifier supplied with this kit makes it easier to see solder bridges. Remove any solder bridges by holding a clean, hot soldering iron tip between the two points that are bridged until the excess solder flows down onto the tip. Compare your foil pattern against the "Circuit Board X-Ray View" on Page 99.
4. Be sure the transistors are in their proper location. Be sure that each lead is in the right hole and has a good solder connection to the foil. Recheck to see if you installed them as shown on Pages 13 and 14.
5. Check the integrated circuits for proper positioning. (Be sure the pin 1 end of each IC is near the marked end of the outline on the circuit board.) Be sure each IC pin is making good contact with its socket. If you remove or handle an IC, be sure to observe the precautions as explained on Page 17.

CAUTION: If it is ever necessary to solder or reheat a connection on a circuit board, remove the integrated circuits first. Always place integrated circuits that have been removed in the conductive foam until you reinstall them.

6. Check each capacitor value. Be sure that a capacitor of correct value is installed at each capacitor location.
7. Check each resistor value carefully. It would be easy, for example, to install an 1800 Ω (brown-gray-red) resistor where a 180 k Ω (brown-gray-yellow) resistor is called for. A resistor that is discolored, or cracked, or shows any sign of bulging would indicate that it is damaged and should be replaced. Since damaged resistors are often the result of some other difficulty (such as faulty wiring), you should find out what caused the damage before you replace the part.
8. Be sure the correct diode is installed at each diode location, and that the banded end is positioned correctly.
9. Check all component leads connected to the circuit boards. Make sure the leads do not extend through the circuit board and come in contact with other connections or parts.

If you still cannot locate and correct the trouble after the above tests are completed, and if a voltmeter is available, check your Computer voltages against the voltages shown on the Schematic Diagram (fold-in) and in the "Circuit Board X-Ray View" (Page 99).

NOTE: In an extreme case where you are unable to resolve a difficulty, refer to the "Customer Service" information inside the rear cover of the Manual. Your Warranty is located inside the front cover of the Manual.

Precautions for Troubleshooting

1. Be sure you do not short any adjacent terminals or foils when making voltage measurements. If the probe slips for example, and shorts together two adjacent connections, it is very likely to damage an IC, transistor or diode.
2. Be especially careful when you test any circuit that contains an IC or transistor. Although these components have an almost unlimited life when used properly, they are much more vulnerable to damage from excessive voltage or current than many other parts.



TROUBLESHOOTING CHART

This chart lists the condition and possible cause of several malfunctions. If a particular part or parts are mentioned (IC2 for example) as a possible cause,

check that part to see that it was installed and/or wired correctly. It is also possible, on rare occasions, for a part to be faulty and require replacement.

PROBLEM	POSSIBLE CAUSE
No display.	<ol style="list-style-type: none"> 1. Batteries (Try AC operation.) 2. Fuse F1. 3. IC4, IC5, IC6.
Keys perform wrong function or enter wrong number.	<ol style="list-style-type: none"> 1. Wires from keyboard to main circuit board.
Same segment on all digits not lit.	<ol style="list-style-type: none"> 1. Connections from IC4 to IC6, and to display. 2. IC6.
Some digits not lit and random information in ones that are lit.	<ol style="list-style-type: none"> 1. Connections from IC4 to IC5. 2. IC5.
One digit not lit.	<ol style="list-style-type: none"> 1. Connections from IC5 to display. 2. IC5.
Display says: IC1	<ol style="list-style-type: none"> 1. Connections from IC1 to IC2. 2. IC1.
IC2	<ol style="list-style-type: none"> 1. D1. 2. IC2 or connections.
IC3	<ol style="list-style-type: none"> 1. D2. 2. IC3 or connections.
Data lost in Standby position.	<ol style="list-style-type: none"> 1. Q1 and associated circuitry.
All decimal points lit or low battery indication not working.	<ol style="list-style-type: none"> 1. Q2, Q3, and associated circuitry.
Single bright digit lit. (Any of the segments may be lit.)	<ol style="list-style-type: none"> 1. Y1. 2. IC4.

SPECIFICATIONS

Basic Architecture	<p>RPN — 5 level stack.</p> <p>Auxiliary Storage — 9 addressable registers. — Last X register.</p>
Display Modes	Variable round-off, fixed point, or scientific notation, 9-digit mantissa, and 2-digit exponent. Automatic display switching.
Data Manipulation	<p>Enter.</p> <p>Store (STO).</p> <p>Roll Down (R↓).</p> <p>X, Y Exchange (X↔Y).</p> <p>Recall (RCL).</p> <p>Change Sign (CHS).</p> <p>Enter Exponent (EN EXP).</p> <p>Clear X (CLR X).</p> <p>Clear Prefix (CLR PRE).</p>
Arithmetic Functions	+ , − , × , ÷ .
Scientific Functions	<p>SIN, COS, TAN</p> <p>SIN⁻¹, COS⁻¹, TAN⁻¹</p> <p>√x, x², y^x, 1/x</p> <p>LOG, 10^x, LN, e^x</p>
Conversions	<p>°F ↔ °C.</p> <p>MI ↔ KM.</p> <p>MI ↔ NAUT.</p> <p>GAL ↔ LTR.</p> <p>H ↔ HMS (Hours, minutes, seconds).</p> <p>RCP ∠ (Reciprocal angle).</p>



Flight Functions	True airspeed calculations. Wind triangle calculations. Up to nine flight leg calculations. Estimated time of arrival. Navigation by two VOR's.
Dynamic Displays	Clock. Elapsed time. Fuel remaining. Distance and time to checkpoints.
Automatic Wind Update	By variation in leg time. By known position entry.
Modes	NORMAL — Full Calculator functions. STANDBY — Saves preflight entries.
Clock Accuracy02%.
Battery Indicator	All decimal points light in low battery condition.
Temperature Range	0°C to 60°C.
Batteries	Four "AA" nickel-cadmium cells. (Approximately two hours use per charge, typically 10 hours use in Standby mode.)
External Power	5 volts DC at 250 mA typical from: — 120 volt AC charger (included). — positive 12-volt DC charger (with cigarette lighter plug, included).
Weight	10.5 oz (300g).
Dimensions	3-1/8" W × 6-3/8" D × 1-3/4" H. (7.9 × 16.2 × 4.5 cm).

The Heath Company reserves the right to discontinue products and to change specifications at any time without incurring any obligation to incorporate new features in products previously sold.

CIRCUIT DESCRIPTION

Refer to the Block Diagram (Illustration Booklet, Page 3) and the Schematic Diagram (Illustration Booklet, Page 4) while you read the following information.

The heart of the Computer is made up of the three microprocessors. Each is, in essence, a separate Computer, programmed within itself to perform specific tasks necessary to the operation of the overall Computer.

IC4 is programmed to control the display and monitor the keyboard. Information to be displayed is output to IC5 and IC6. IC5 scans each of the 14 digits, enabling each digit to light at a specific time. IC6 turns on the appropriate display segments or decimal point for each digit as that digit is enabled. Each digit is scanned approximately 100 times each second.

Scanning is also used to determine which keys are pressed. The keyboard is organized in a matrix. Lines A through J are enabled one at a time, and pressing a key causes the signal to reach one of the inputs to IC4 at K, L, M, or N. IC4 "knows" which keyboard row (A — J) is enabled and which column (K — N) receives an output, and can therefore determine which key is pressed.

The microprocessors "talk" to each other (pass data from one processor to another) by way of the proces-

sor busses. IC3 performs much of the math and scientific functions, and IC2 performs the navigation and flight functions. IC2 also transfers data to be stored in the memory circuit, IC1.

IC1 stores preflight data in the Standby mode because power is maintained to this IC only. When the Computer is returned to the ON mode, IC4 can then retrieve the data stored in IC1.

Power for the Computer may come from the internal, 4-cell, 5-volt, nickel-cadmium battery or the AC or DC converter/charger. These chargers provide power for the Computer while they charge the internal battery.

Transistor Q1 and its associated components provide a signal to IC1 and IC2 in the Standby mode.

Transistors Q2, Q3, and their associated parts form a low-battery indicator which turns on all the decimal points in the display when the battery voltage falls below approximately 4.6 volts.

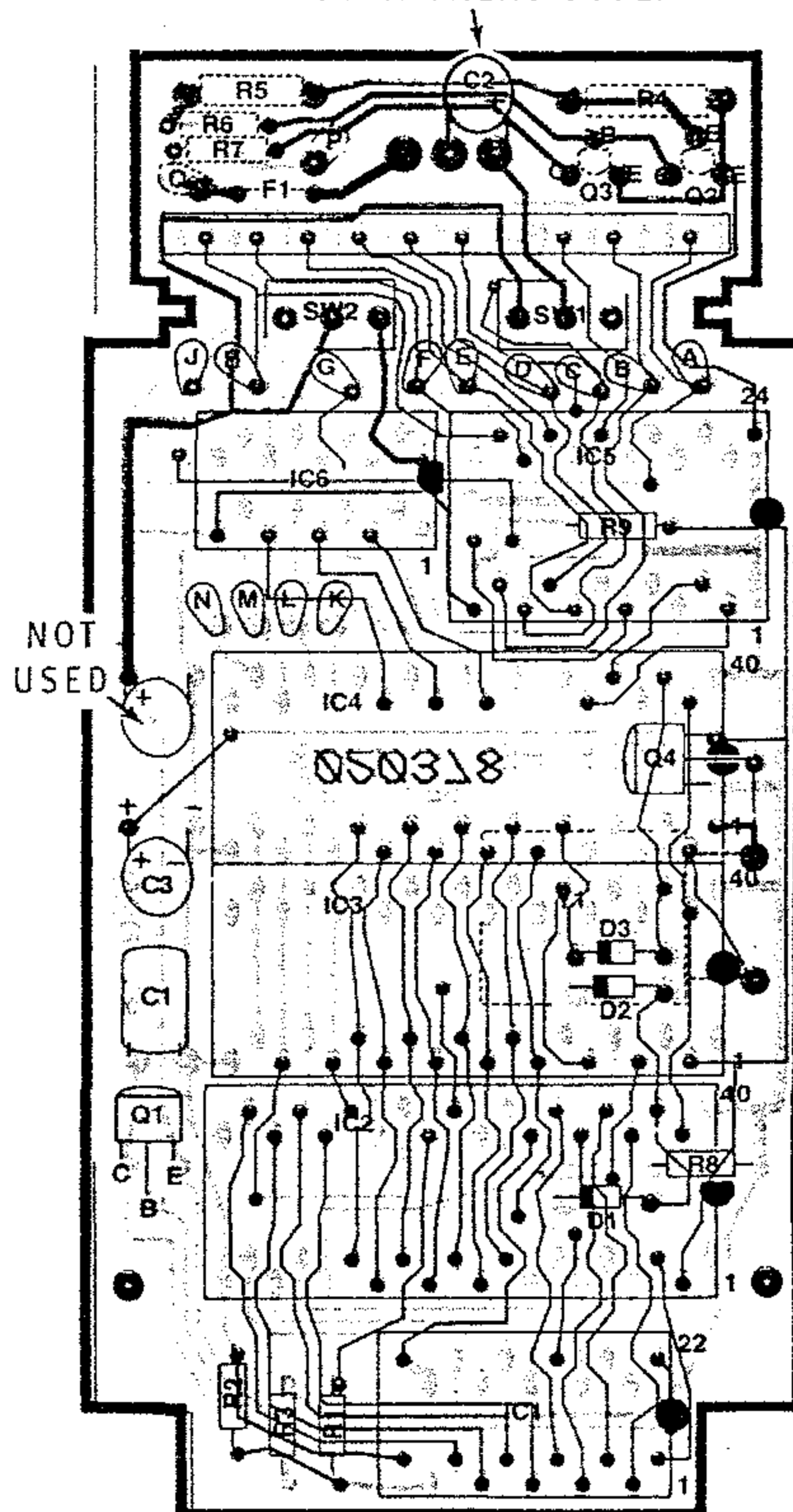
A quartz crystal oscillator is made up of crystal Y1 and the internal circuitry of IC4. To prevent excessive loading, the output signal from the oscillator is buffered by transistor Q4 before the signal is distributed to IC2 and IC3.



CIRCUIT BOARD X-RAY VIEW

(VIEWED FROM FOIL SIDE)

(MOUNTED ON
COMPONENT SIDE)

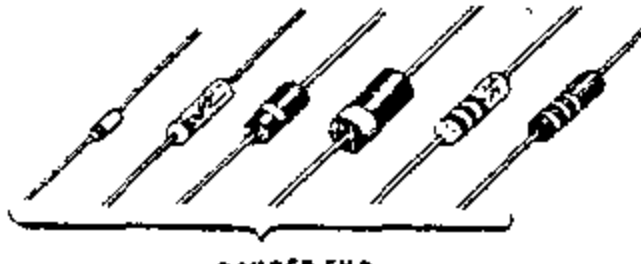
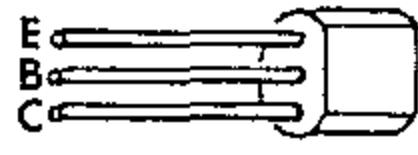
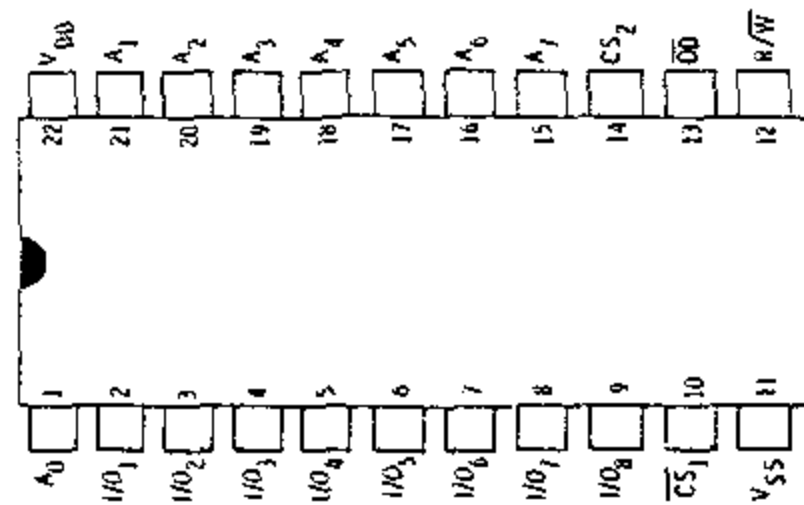
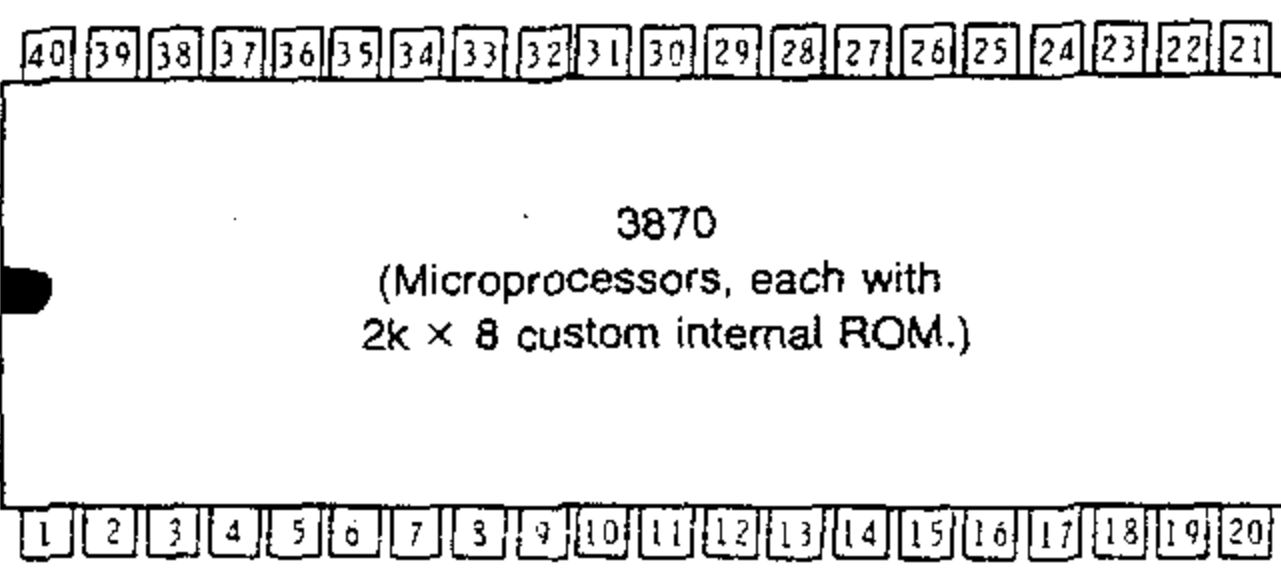


NOTE: To find the PART NUMBER of a component for the purpose of ordering a replacement part:

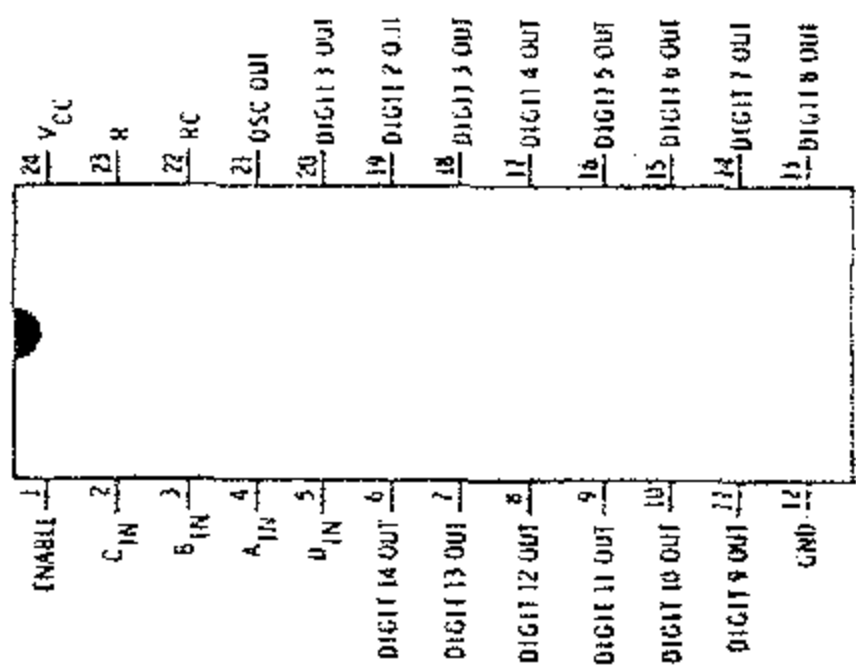
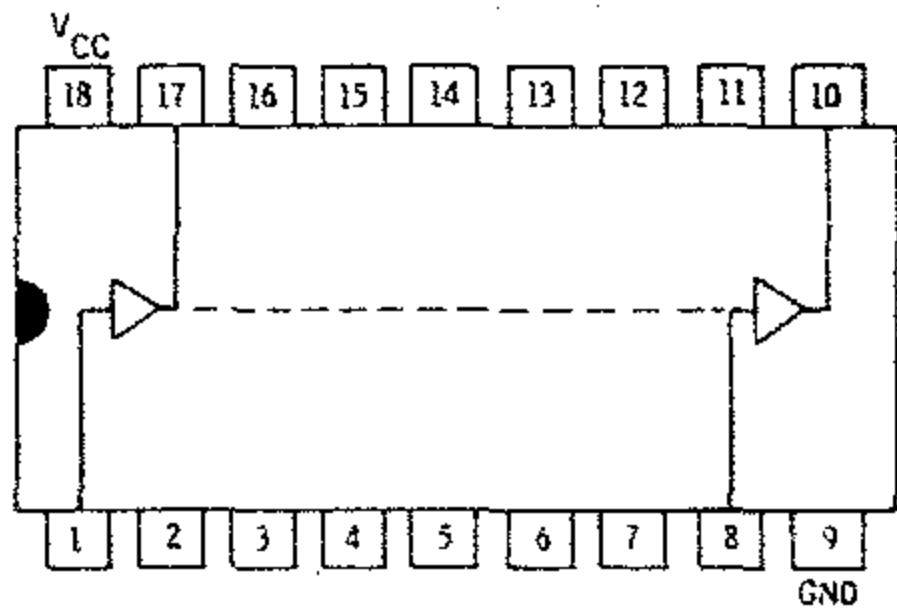
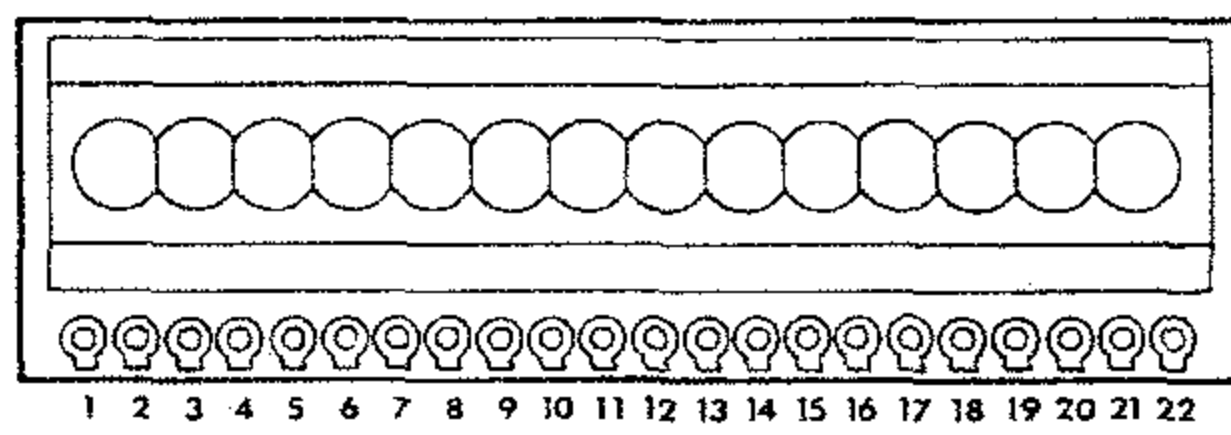
- A. Find the circuit component number (R5, C3, etc.) on the "X-Ray View."
- B. Locate this same number in the "Circuit Component Number" column of the "Parts List" in the front of this Manual.
- C. Adjacent to the circuit component number, you will find the PART NUMBER and DESCRIPTION which must be supplied when you order a replacement part.

(Component side foil shown in red)

SEMICONDUCTOR IDENTIFICATION CHART

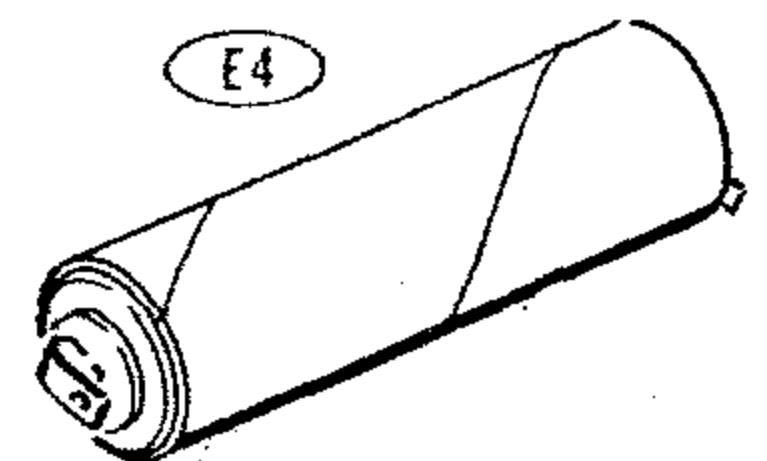
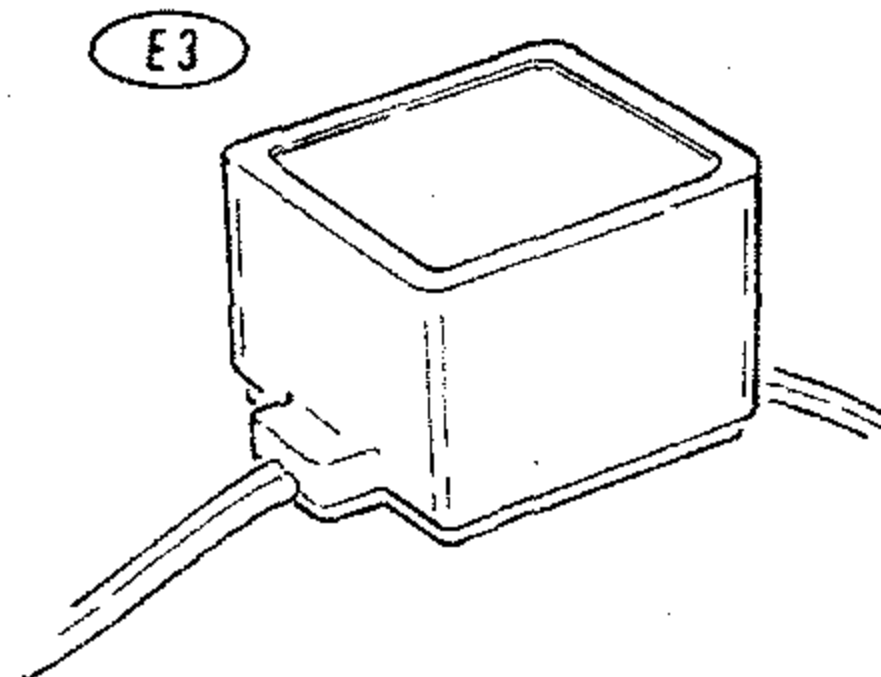
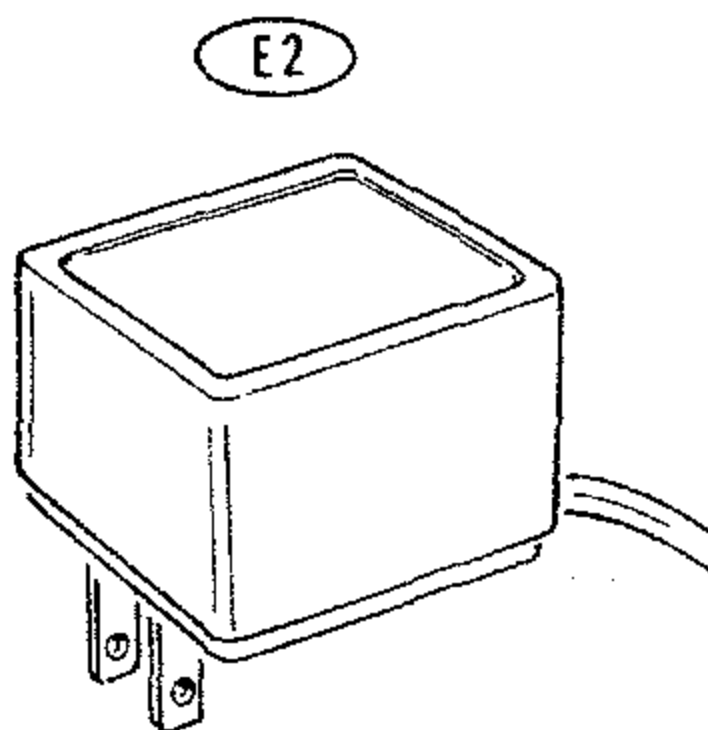
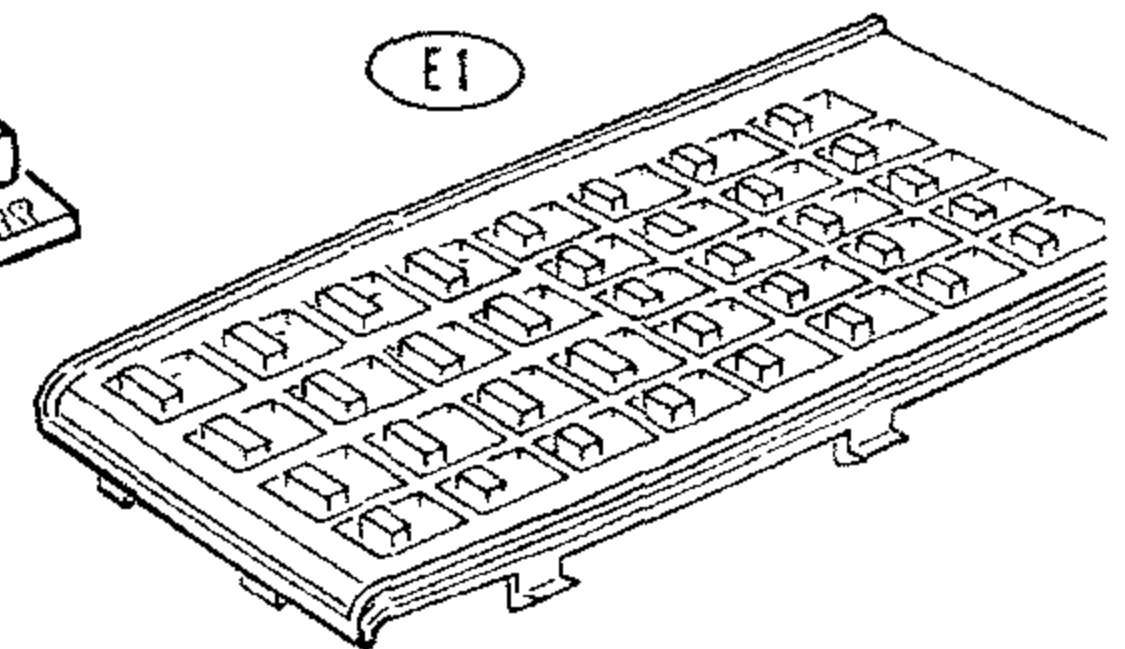
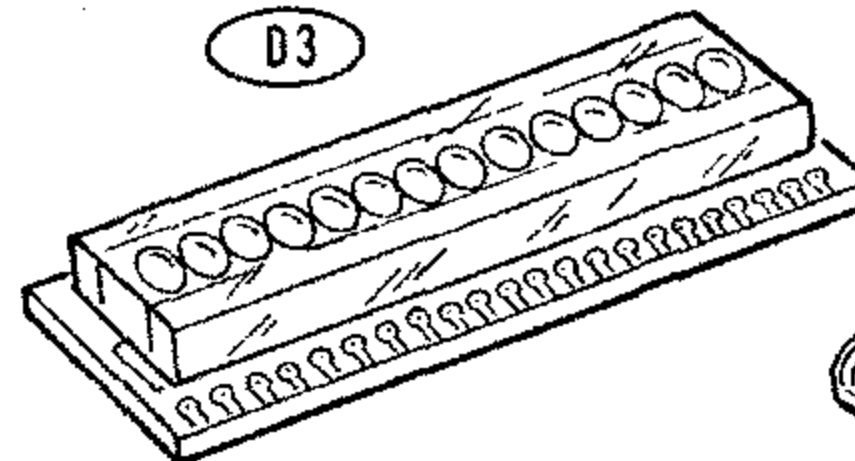
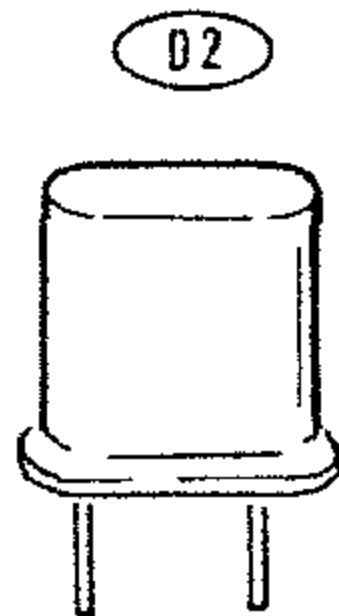
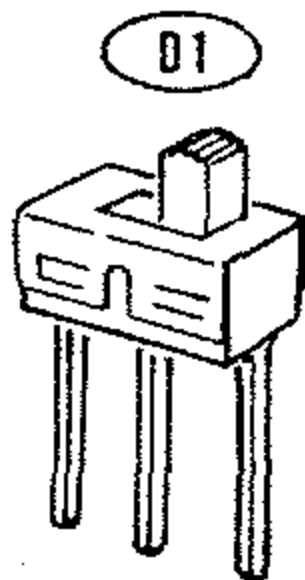
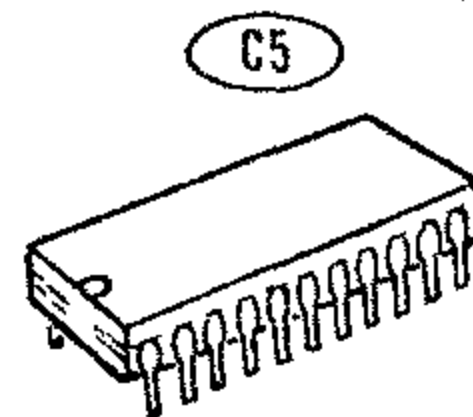
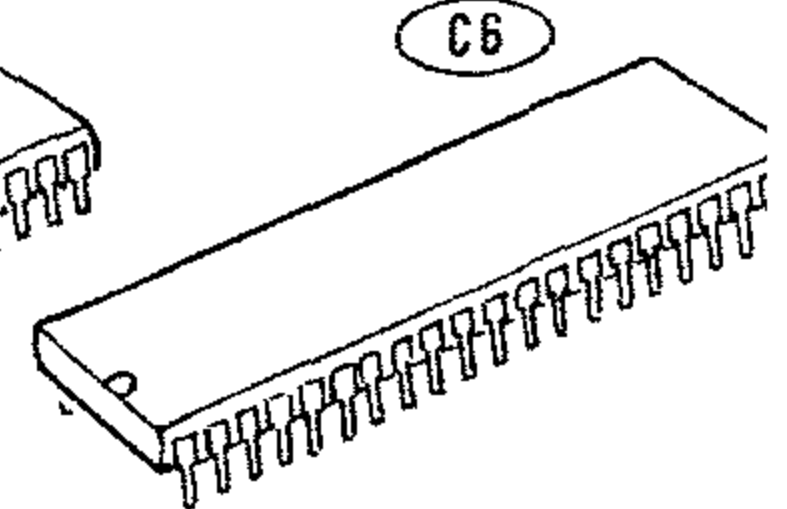
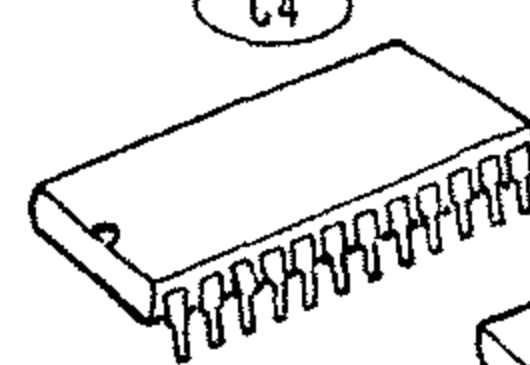
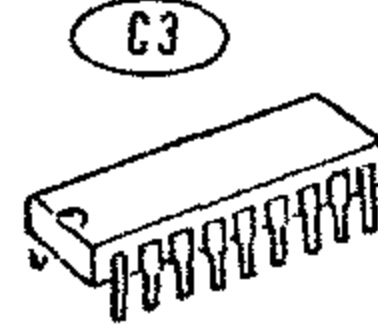
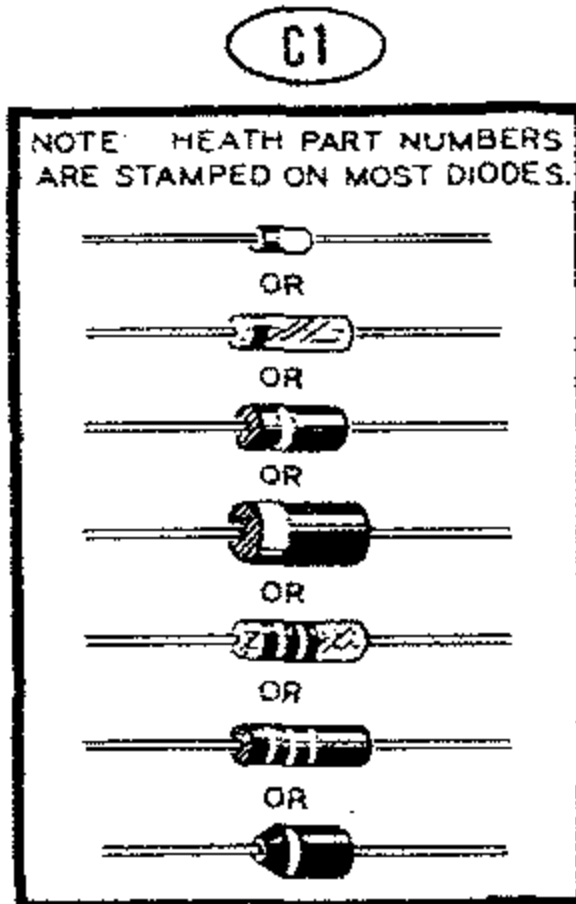
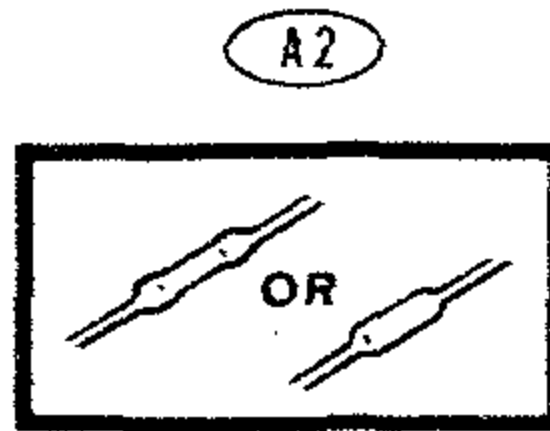
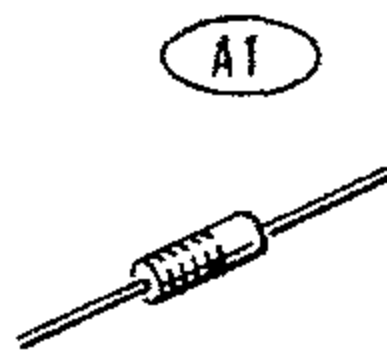
COMPONENT	HEATH PART NO.	MAY BE REPLACED WITH	IDENTIFICATION
D1, D2, D3	56-602	Germanium diode, 200 mA, 10V.	<p>IMPORTANT: THE BANDED END OF DIODES CAN BE MARKED IN A NUMBER OF WAYS.</p>  <p>BANDED END</p>
Q1, Q2, Q3	417-235	2N4121	
Q4	417-801	MPSA20	
IC1	443-845	3539 (256X8 RAM)	
IC4 IC3 IC2	444-14 444-15 444-16		 <p>3870 (Microprocessors, each with 2k × 8 custom internal ROM.)</p>



COMPONENT	HEATH PART NO.	MAY BE REPLACED WITH	IDENTIFICATION																																														
IC5	443-847	DS8664 (Digit decoder driver)																																															
IC6	443-846	DS8867 (Constant current segment driver)																																															
DISPLAY	411-828	5082-7447	 <table><thead><tr><th>Pin No.</th><th>5082-7447 Function</th></tr></thead><tbody><tr><td>1</td><td>Cathode - Digit 1</td></tr><tr><td>2</td><td>Cathode - Digit 2</td></tr><tr><td>3</td><td>Cathode - Digit 3</td></tr><tr><td>4</td><td>Anode - Segment c</td></tr><tr><td>5</td><td>Cathode - Digit 4</td></tr><tr><td>6</td><td>Anode - DP</td></tr><tr><td>7</td><td>Cathode - Digit 5</td></tr><tr><td>8</td><td>Anode - Segment a</td></tr><tr><td>9</td><td>Cathode - Digit 6</td></tr><tr><td>10</td><td>Anode - Segment e</td></tr><tr><td>11</td><td>Cathode - Digit 7</td></tr><tr><td>12</td><td>Anode - Segment d</td></tr><tr><td>13</td><td>Cathode - Digit 8</td></tr><tr><td>14</td><td>Anode - Segment g</td></tr><tr><td>15</td><td>Cathode - Digit 9</td></tr><tr><td>16</td><td>Anode - Segment b</td></tr><tr><td>17</td><td>Cathode - Digit 10</td></tr><tr><td>18</td><td>Anode - Segment f</td></tr><tr><td>19</td><td>Cathode - Digit 11</td></tr><tr><td>20</td><td>Cathode - Digit 12</td></tr><tr><td>21</td><td>Cathode - Digit 13</td></tr><tr><td>22</td><td>Cathode - Digit 14</td></tr></tbody></table>	Pin No.	5082-7447 Function	1	Cathode - Digit 1	2	Cathode - Digit 2	3	Cathode - Digit 3	4	Anode - Segment c	5	Cathode - Digit 4	6	Anode - DP	7	Cathode - Digit 5	8	Anode - Segment a	9	Cathode - Digit 6	10	Anode - Segment e	11	Cathode - Digit 7	12	Anode - Segment d	13	Cathode - Digit 8	14	Anode - Segment g	15	Cathode - Digit 9	16	Anode - Segment b	17	Cathode - Digit 10	18	Anode - Segment f	19	Cathode - Digit 11	20	Cathode - Digit 12	21	Cathode - Digit 13	22	Cathode - Digit 14
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ILLUSTRATION

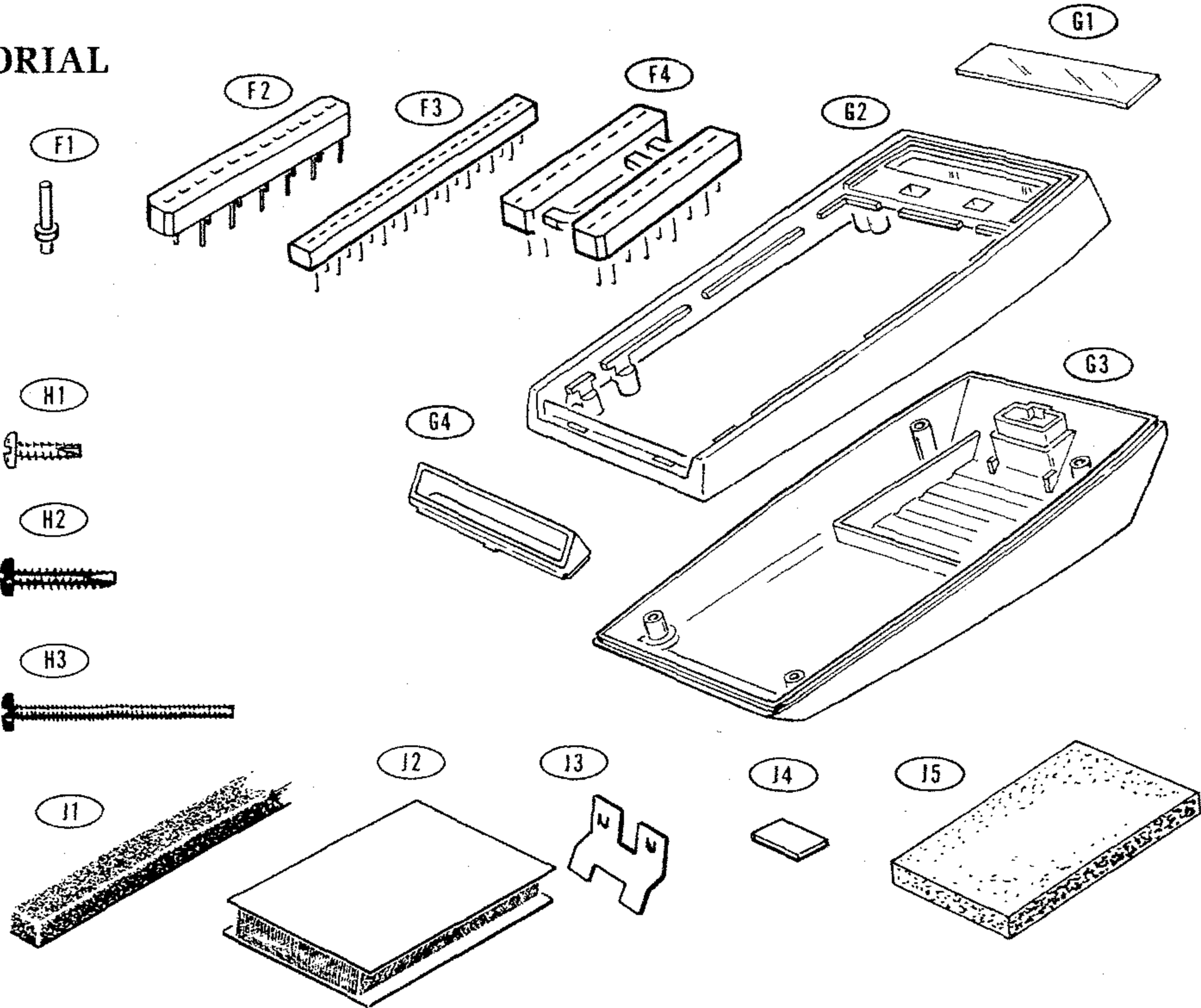
PARTS



ON BOOKLET

Part of 595-2040

CTORIAL



390-1453

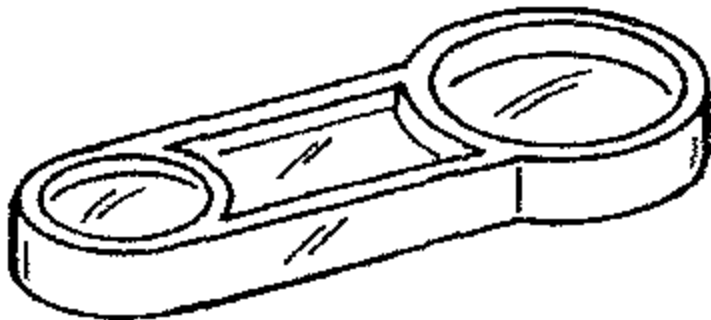
OFF		ON		NORMAL		STANDBY	
Heathkit Aircraft Navigation Computer OC-1401				Preflight			
				In-flight			
				Navigation			
CAS	FALT	FUEL	WIND	LAST Δ			
°C	BAR	RATE	LEG	Δ			
ST LEG		POSΔ	FUEL	ETA	ETAΔ	9/T DES	
LEG		TAS	MH	GS	TE	WIND	D/T Δ
RAD 1		VR12	VR1P				
RAD 2		VR1Δ	DSY MH	E	F-1		
CLR PRE		ACP L	ROL	STO	CLR ET		
CLR A		CHS	EN EXP	ENTER	S/S	ET	
M = HMS		M1 = HMT	°F = °C		SET CLR		
7		8		9		+	
CAL = LTR		M1 = RM	LOG 10 ²		LW x ²		
4		5		6		-	
SIN -1		COS -1		TAN -1		1-1 RT	
1		2		3		X	
VE 1 ²		R1A 30A		5/4		Y ² 1ST RT	
0		*		Δ		÷	

Preflight
Key in all preflight data. To recall data: CL press **CL** or **CLR**.
VR12 and **VR1Δ** for VOR navigation.
STANDBY
Data may be saved in standby mode while in transit to airport.

In-flight
STANDBY
Switch from standby to normal mode.
Set clock to current time.
10²
Start elapsed time when engine is started.
At start of first leg, start leg 1 (1st. M₁) and computer will give TAS MH.
RT
Gives distance and time to checkpoint.
Δ
Starts next leg and updates wind.
10²
Starts leg_n with same wind.

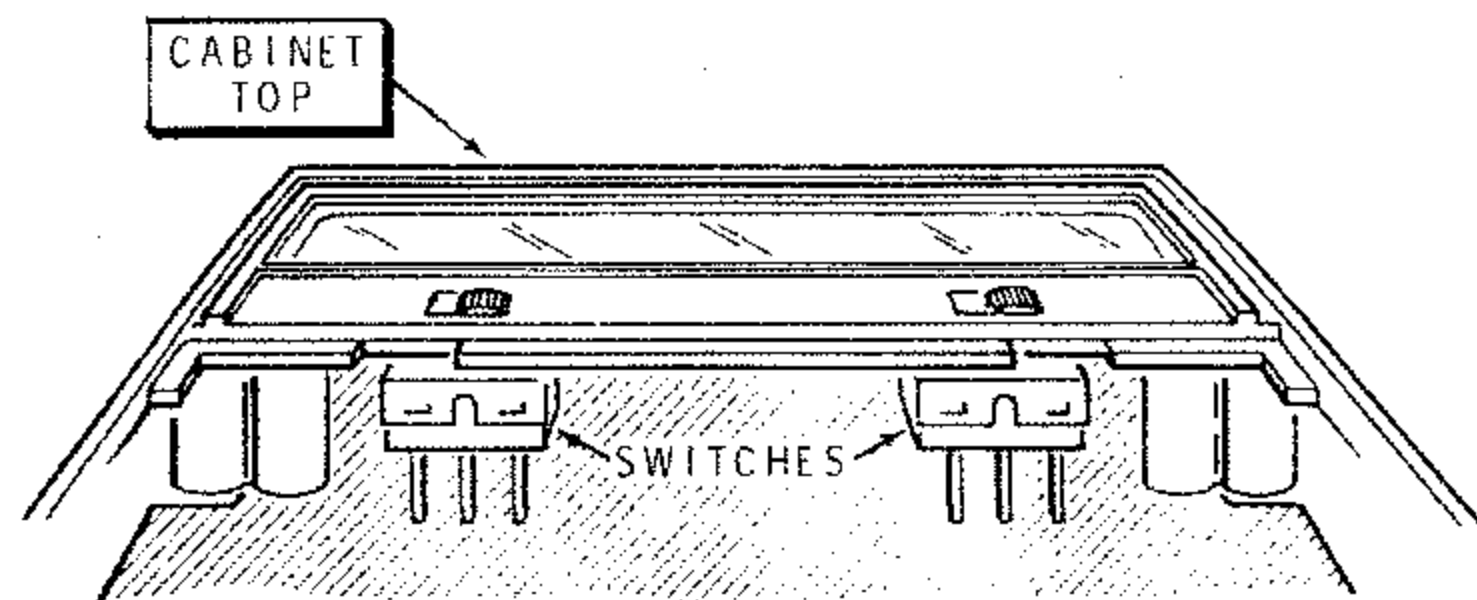
Navigation
Key in VR12 and VR1Δ (may be preflighted).
RT
During flight, key in radial 1 and radial 2.
CLR MH
Gives distance and magnetic heading to destination and updates flight leg information.

Heath Company - Randon Harbor, Michigan 49022

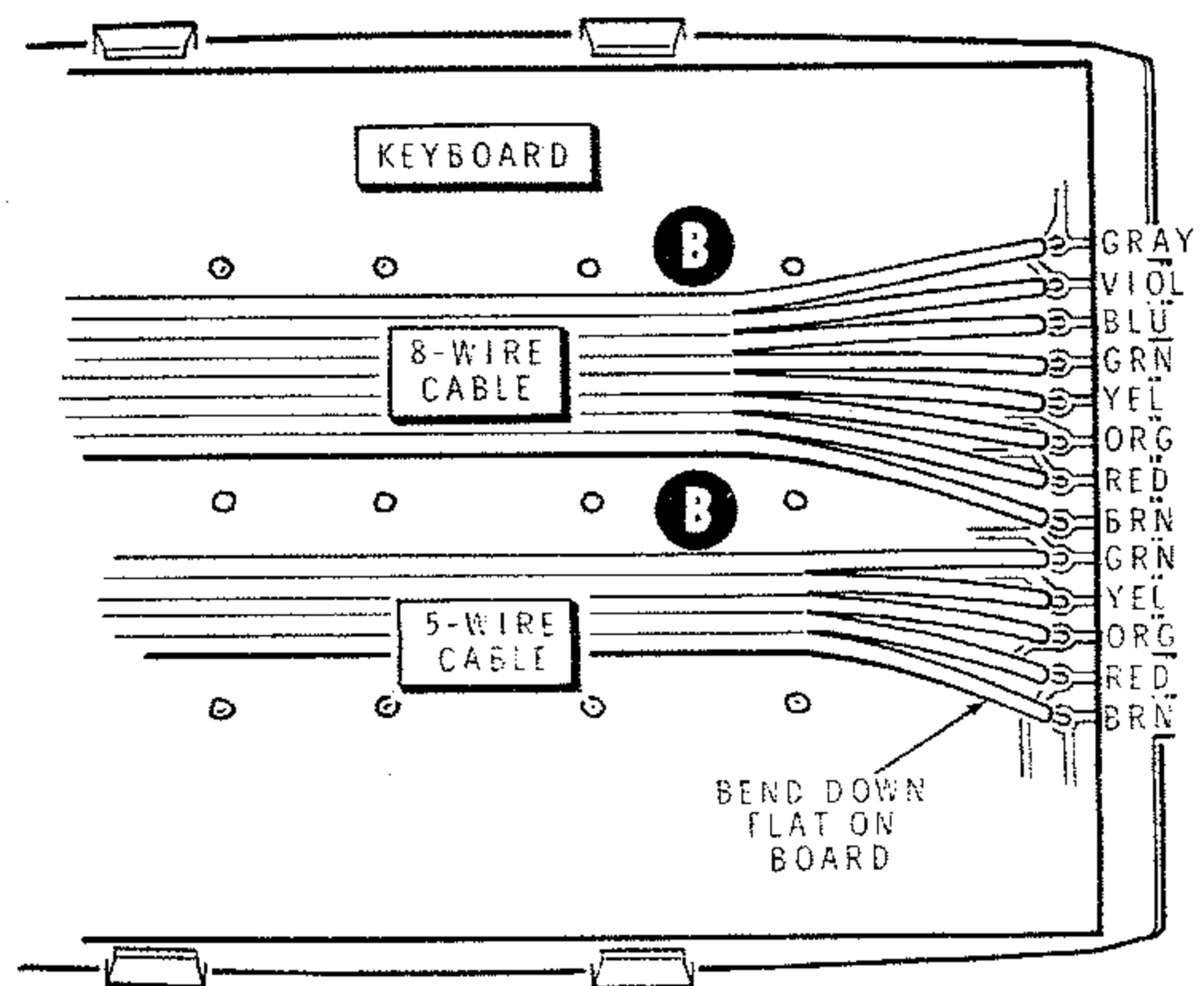


MODEL OC-1401

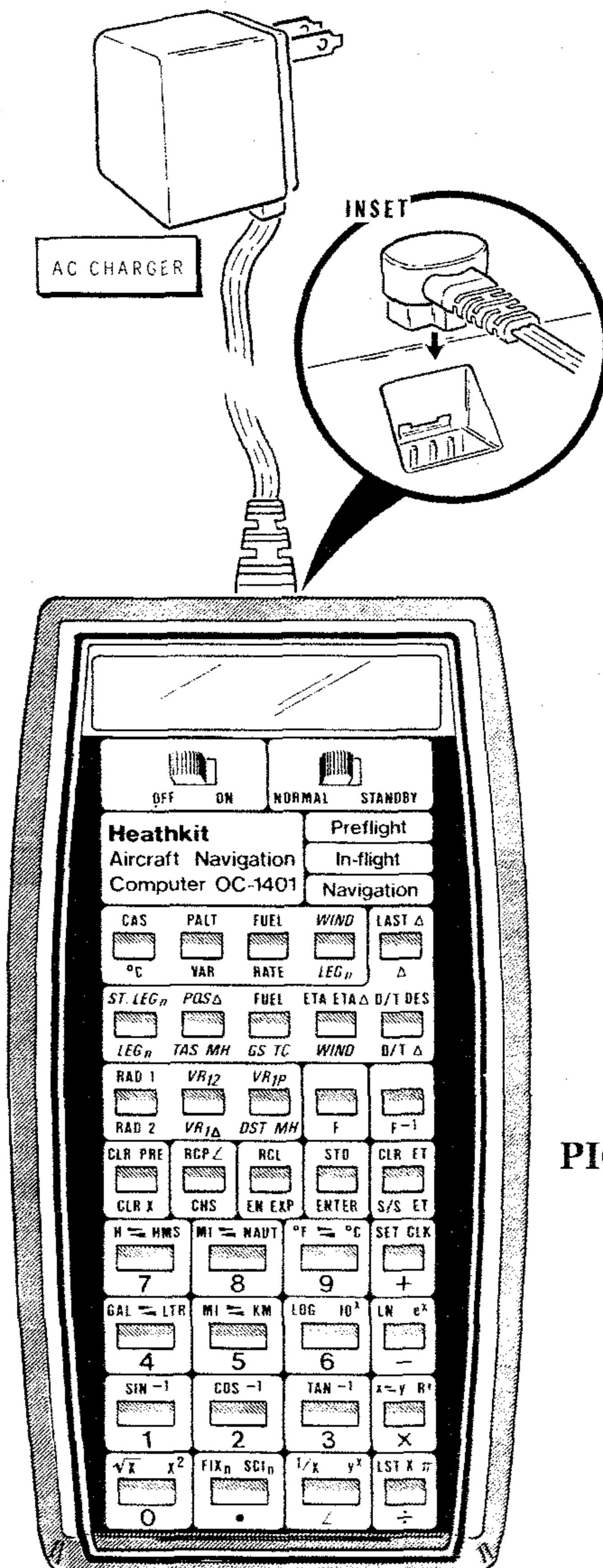
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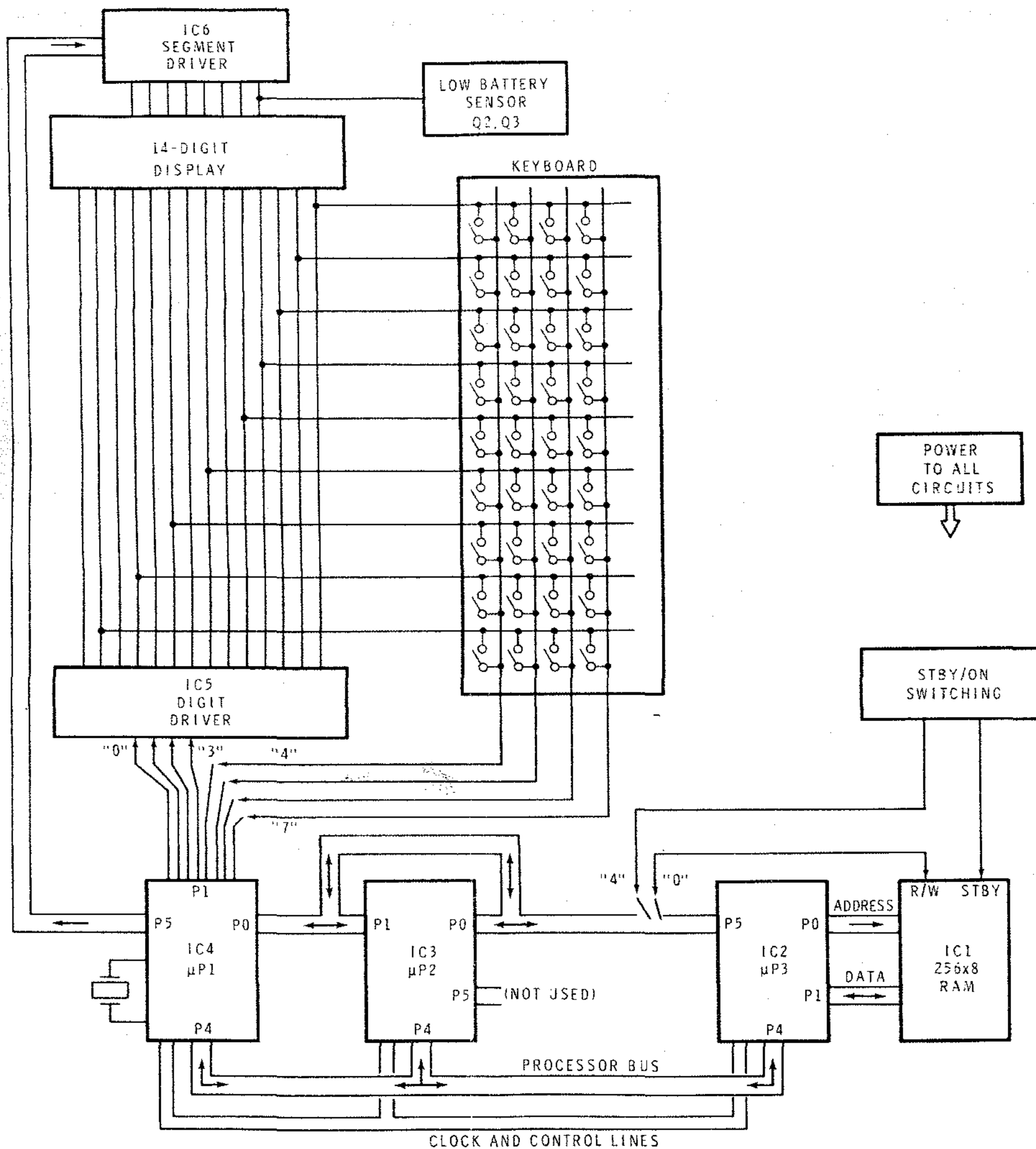
Detail 3-2D



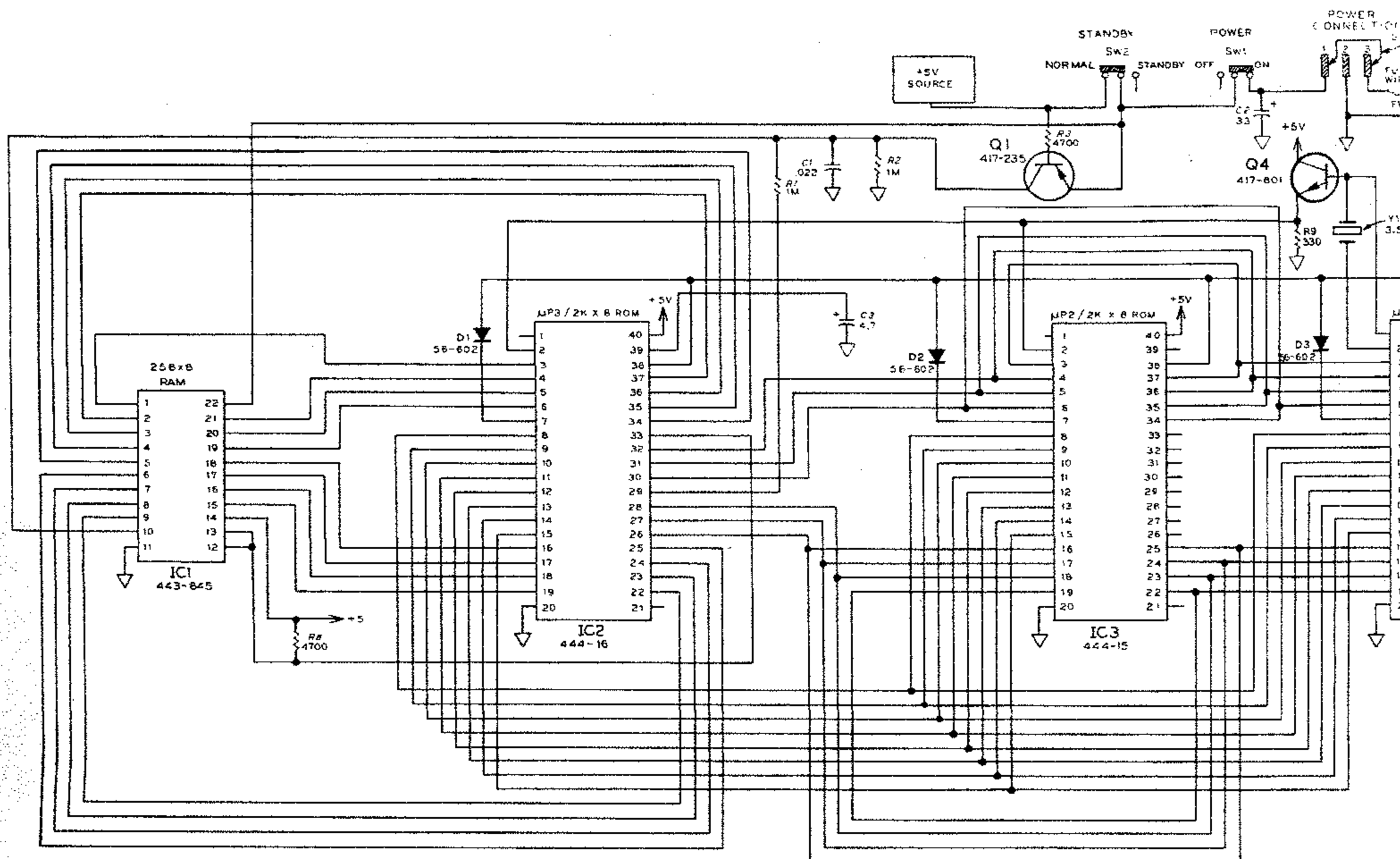
PICTORIAL 3-4



PICTORIAL 3-6



BLOCK DIAGRAM



**SCHEMATIC OF THE
HEATHKIT®
AIRCRAFT NAVIGATION COMPUTER
MODEL OC-1401**

NOTES:

1. ALL RESISTORS ARE IN OHMS. K=1000; M=1,000,000.
2. ALL CAPACITORS ARE IN MICROFARADS (μF).
3. ▽ THIS SYMBOL INDICATES CIRCUIT BOARD GROUND.

